MIDLANT BUILDING ENVELOPE AIR TIGHTNESS CRITERIA

PURPOSE: Provide a building envelope continuous air sealing barrier to reduce infiltration.

BUILDING ENVELOPE SEALING PERFORMANCE REQUIREMENT: Design and construct the building envelope with a continuous air seal barrier to control air leakage into, or out of, the conditioned space.

A. DESIGN: Clearly identify all air barrier components of each envelope assembly on construction documents; detail the joints, interconnections and penetrations of the air barrier components. Clearly identify the boundary limits of the building air barriers, and of the zone or zones to be tested for building air tightness on the drawings. Trace a continuous plane of air-tightness throughout the building envelope, and make flexible and seal all joints.

B. CONSTRUCTION: The air seal barrier material(s) must have an air permeance not to exceed 0.004 CFM/SF at 0.3" WG [0.02 L/s.m2 @ 75 Pa] when tested in accordance with ASTM E 2178 (2003).

(1) Join and seal the air barrier material of each assembly to the air barrier material of adjacent assemblies in a flexible manner, allowing for the relative movement of these assemblies and components.

(2) Support the air seal barrier in a method to withstand the maximum positive and negative air pressure to be placed on the building without displacement or damage, and transfer the load to the structure.

(3) Seal all penetrations of the air seal barrier. If any unavoidable penetrations of the air barrier by electrical boxes, plumbing fixture boxes, and other assemblies are not airtight, make them airtight by sealing the assembly and the interface between the assembly and the air barrier, or by extending the air barrier over the assembly. The air seal barrier must be durable to last the anticipated service life of the assembly.

(4) Do not install lighting fixtures with ventilation holes through the air barrier.

(5) Provide a motorized damper in the closed position and connected to the fire alarm system to open on call and fail in the open position for any fixed open louvers such as at elevator shafts.

(6) Damper and control to close all ventilation or make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc., when leakage can occur during inactive periods.

(7) Compartmentalize garages under buildings by providing airtight vestibules at building access points.

(8) Compartmentalize spaces under negative pressure such as boiler/mechanical rooms and provide make-up air for combustion.

PERFORMANCE CRITERIA AND SUBSTANTIATION: Submit the qualifications and experience of the testing entity for approval. Demonstrate performance of the continuous air barrier for the opaque building envelope by the following tests:

A. Test the completed building and demonstrate that the air leakage rate of the building envelope does not exceed 0.25 CFM/SF at a pressure differential of 0.3" w.g.(75 Pa) in accordance with ASTM E779 (2003) or E-1827-96 (R2007). Accomplish tests using either pressurization or depressurization or both. Divide the volume of air leakage in CFM @ 0.3" w.g. (L/s @ 75 Pa) by the area of the pressure boundary of the building, including roof or ceiling, walls and floor to produce the air leakage rate in CFM/SF @ 0.3" w.g. (L/s.m2 @ 75 Pa). Do not test the building until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions so that repairs to the continuous air seal barrier, if needed to comply with the required air leakage rate, can be done in a timely manner.

B. Test the completed building using Infrared Thermography testing. Use infrared cameras with a resolution of 0.1deg C or better. Perform testing on the building envelope in accordance with ISO 6781:1983 and ASTM C1060-90 (R2003). Determine air leakage pathways using ASTM E 1186-03

(R2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Seal Barrier Systems, and perform corrective work as necessary to achieve the whole building air leakage rate specified in above.

C. Notify the Government at least three working days prior to the tests to provide the Government the opportunity to witness the tests. Provide the Government written test results confirming the results of all tests.

SECTION 07 25 00.00 22

BUILDING AIR BARRIER SYSTEM
04/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 1060	(2011) Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM D 4541	(2009e1) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E 84	(2010b) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 1827	(1996, R2007) Standard Test Method for Determining Air Tightness of Buildings Using An Orifice Blower Door

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 6781	(1983) Thermal Insulation - Qualitative Detection of Thermal Irregularities in Building Envelopes - Infrared Method

UNITED STATES ARMY CORP OF ENGINEERS(USACE)

1.2 RELATED WORK AFFECTED BY THIS SECTION

The air barrier system requires close and frequent coordination between the contractor and sub-contractors as well as between sub-contractors. As a result it is the contractor responsibility to assure that all such trades have a complete understanding of their responsibilities. Below is a partial list of specifications that will be affected.

[Section 01 45 00.00 20 - QUALITY CONTROL; for coordination with contractors independent testing and inspection agency.]

[Section 01 45 00.05 20 - DESIGN AND CONSTRUCTION QUALITY CONTROL; for coordination with contractors independent testing and inspection agency.]

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

All materials, methods and expertise that contribute to an airtight building enclosure and controls infiltration or exfiltration of air located

in the non-accessible construction shall not exceed the maximum air permeance noted in this specification. This includes sealing of all penetrations, joints and transitions between materials, products, and assemblies forming the airtightness of the building enclosure which is "the air barrier system" or ABS.

a. Provide materials and installation methods for a complete building Air Barrier System providing an airtight barrier conforming to the Performance Requirements specified in this Section between the conditioned interior building atmosphere and the exterior atmosphere; and located as shown on the Drawings.

b. Provide materials and installation methods to bridge and provide an airtight connection/seal, conforming to the Performance Requirements specified in this Section. All materials to be compatible in adhesion and chemically. The following air leakage pathways and gaps, including, but not limited to the following;

    1. Between the wall air barrier and the roof air barrier.
    2. Between the wall air barrier and the foundation or under slab air/vapor barrier.
    3. Between the slab on grade under slab air/vapor barrier and the foundation or wall air barrier.
    4. Between different substrate or exterior cladding materials/systems.
    5. Between the various different air barrier products/systems
    6. At masonry control joints.
    7. At expansion joints, including airtight connection to adjacent air barriers.
    8. Between the wall air barrier and window frames, storefront frames, wall louvers, etc
    9. Between the wall air barrier and door frames.
    10. Between the air barrier and any penetrations, including penetrations by piping, conduit, duct, structural members and similar.
    11. Masonry ties, screws, bolts and similar penetrations.
    12. All other air leakage pathways in the building air barrier envelope.

c. Exterior wall systems behind metal panel;

    1. Temperature resistant: Provide high temperature resistant materials and installation methods so assure barrier performance and life cycle requirements.

    2. UV Resistance: Metal panel systems with open joints shall require the barrier membrane and bridging materials to provide permanent resistance to UV exposure.

    3. Life Safety Performance: Verify if, Surface Burning Characteristic Testing per ASTM E 84 is a code requirement and if so include all components of the barrier system.

1.3.2 Performance Requirements

The air barrier to be furnished shall be constructed to perform as a continuous barrier that will remain adhered in place and durable for the life of the building and conform to the following requirements.

a. Building Air Barrier System: The completed building shall have an air

leakage rate that does not exceed 0.25 cfm/ft2 at a pressure differential of 0.3” w.g. (1.57 psf or 75 Pa) when tested in accordance with the USACE Test Protocol.

b. Air Barrier Materials Air Permeance: Not to exceed 0.004 cubic feet per minute per square foot under a pressure differential of 0.3” w.g. (1.57 psf or 75 Pa) when tested in accordance with ASTM E2178.

c. Air Barrier Assembly Air Permeance: Not to exceed 0.040 cubic feet per minute per square foot under a pressure differential of 0.3” w.g. (1.57 psf or 75 Pa) when tested in accordance with ASTM E2357

d. ABS shall accommodate movements of building materials by providing for airtight barrier across building expansion and control joints.

e. ABS shall accommodate changes in substrate and perimeter sealing conditions.

f. Different air barrier products shall be permanently joined together where they meet in a manner approved by both manufacturers to provide an airtight juncture. These materials shall be compatable in both adhesion and chemical mackup.

The installed building Air barrier System shall conform to the following requirements:

a. Continuous, with all joints made air and water tight.

b. Structural Integrity: ABS shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure.

c. Shall not displace adjacent materials under full load.

d. Shall be joined in an air-tight, watertight and flexible manner to the air barrier material of adjacent systems, allowing for the relative movement of systems due to thermal and moisture variations and creep.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only.] The following shall be submitted in accordance with Section [01 33 00 SUBMITTAL PROCEDURES][01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES]:

SD-03 Product Data

Building Air Tightness Test Procedures; [; G]

The Contractor shall submit, no later than 60 days after Notice to Proceed; detailed test methods, procedures, test apparatus and analysis methods to be employed for the Building Air Tightness Test.

Building Air Thermography Survey Procedures; [; G]

The Contractor shall submit, no later than 60 days after Notice to

Proceed; detailed test methods, procedures, test apparatus and analysis methods to be employed for the Thermography Test.

Air Barrier Systems [; G]

Manufacturer's catalog data specifically indicating which items are in this contract.

Prior to commencing the Work, submit manufacturers product data, samples and complete set of standard details for the air barrier membrane system showing a continuous plane of air tightness throughout the building envelope.

SD-06 Test Reports

Test Reports; [; G]

The inspection and testing agency will submit a certified written report, in duplicate, of each inspection, test, or similar service to the Contractor with duplicate copies to the Contracting Officer not later than 10 days after each test.

Report Data: Written reports of each inspection and test or similar service shall include all the Report items described in ASTM E 1827. Additionally, the report shall also include the following information:

a. Date of Issue
b. Project title and number
c. Name, address, and telephone number of testing agency
d. Dates and locations of samples and tests or inspections
e. Names of individuals making the inspection or test
f. Designation of the Work and test method
g. Identification of product and Specification Section
h. Complete inspection or test data
i. Test results and an interpretation of test results
j. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements
k. Name and signature of laboratory inspector
l. Recommendations on retesting

Building Air Tightness Test Reports; [;G]

The Building Air Tightness Test analysis, and report shall be submitted not later than 10 days after the test.

Thermography Test Report [;G]

The Thermography Test analysis, and report shall be submitted not later than 10 days after the test.

SD-07 Certificates

Prior to commencing the Work, submit copies of manufacturers current ISO certification. Membrane, primers, sealants, and adhesives shall be included.

Prior to the air tightness test, the contractor shall submit evidence that the test equipment has been calibrated within the

past year.

1.5 QUALITY ASSURANCE

The Contractor shall engage a prequalified third party organization, including independent testing laboratories, specialized in the types of air barrier system inspections and tests to be performed. These tests include, but not limited to; Building Air Tightness Test Procedures, Building Air Thermography Survey Procedures

a. Air Barrier Association of America Quality Assurance Program (ABAAQAP)

An Air Barrier Association of America Quality Assurance Program (ABAA QAP) shall be implemented to provide a level of assurance that specific products are installed correctly and specific services are being provided to the highest possible standards. An ABAA QAP monitors standards and specifications, manufacturer accreditation, contractor accreditation, installer training and accreditation, documentation and reporting, third party audits, and database tracking.

b. ABAA Accredited Contractors

The Contractor shall have met the ABAA's mandatory quality assurance and training requirements and shall be accredited through the ABAA prior to installation of products that form part of the air barrier system. Failure to meet this requirement shall be grounds for the Contracting Officer to stop the work.

c. ABAA Certified Installers
The Installer(s) shall have met the ABAA's mandatory quality assurance and training requirements and shall be accredited through the ABAA prior to installation of products that form part of the air barrier system.

1.5.1 On Site Quality Control

The Installers are required to undertake quality control measures on a daily basis. They shall have completed air barrier training and shall utilize equipment to inspect and test the quality of their work to ensure the installation of products that form a part of the air barrier system conform to the standards outlined in the ABAA QAP.

1.5.2 Documentation and Reporting

Installers shall document the entire installation process on daily job site reports. These Test Reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results. Every job site report, including the Building Air Tightness Test Reports and the Thermography Test Report is data based and reviewed by the Quality Assurance Program Manager.

1.5.3 Third Party Audits

Third party audits are part of the ABAA QAP (Quality Assurance Program). Independent auditors shall review the Contractor's and Installer's adherence to the ABAA QAP, which includes installation instructions, manufacturer's recommendations, and the overall quality of the air barrier

system. All administrative and managerial aspects of the ABAA Quality Assurance Program, such as accreditation, audits, conflict resolution, and documentation review are handled by third party organizations. The Contractor shall notify the Contracting Officer 5 days in advance of a scheduled audit and a report shall be provided to the Contracting Officer within 14 days following the onsite audit. A minimum number of audits ABAA will conduct is based on the contract value. However, if additional audits are required by the Contracting Officer due to installation procedures not meeting the QAP the contractor shall bear all additional costs.

1.5.4 Pre-Construction Conferences

The Contractor shall organize pre-construction conferences between the sub-contractors involved in the construction of the air barrier system to discuss where each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, and transitions between materials, products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.6 BUILDING AIR TIGHTNESS TEST TECHNICIAN RESPONSIBILITIES

1.6.1 Airtightness

The testing technician shall have a minimum of 2 years documented experience in air tightness using the fan pressurization methods in accordance with USACE Test protocol on building of similar size and complexity. Have ABAA certification. The technician shall:

a. Describe the test procedures, test apparatus, and analysis method.

b. Perform the Building Air Tightness Test.

c. Demonstrate a thorough working knowledge and understanding of building construction, and in particular exterior envelope systems and HVAC systems.

d. Participate in identifying deficiencies in the building construction upon failure of a test to meet the specified leakage rate.

e. Submit a report of each air tightness test whether successful or not.

f. Submit a report of each thermography test identifying problem areas.

1.6.2 Thermography

a. Level I Thermography Certification or have documented equivalent education and training meeting this requirement.

b. A thorough knowledge of the operation of the particular infrared imaging system being used.

c. The ability to interpret thermographs and other data used in air barrier testing.

1.7 CONTRACTOR RESPONSIBILITIES

The Contractor is responsible for the construction of an air barrier system that is contiguous and connected across the six surfaces of the building

envelope meeting the performance requirements as outlined in this specification.

The Contractor shall perform a building air tightness test and thermography test to demonstrate that the building envelope is properly sealed and insulated. The testing shall be performed in accordance with the procedures outlined in this specification.

1.7.1 Coordination of Sub-Contractor(s)

The Contractor shall provide coordination between the Sub-Contractors involved in the construction of the air barrier system, coordinate the sequence of construction to ensure continuity of the air barrier system joints, junctures, and transitions between materials and assemblies of materials and products from substructure to walls to roof. The Contractor shall provide quality assurance procedures, testing and verification as specified herein. The Contractor shall facilitate inspections, tests, and other quality control services specified elsewhere in the Contract Documents and required by the Contracting Officer. These coordination efforts are critical to avoid costly removal and replacement of construction materials to accommodate inspections and tests. The cost of all tear out and rework shall be at the Contractors expense, not the expense of the subcontractor(s).

1.7.2 Construction Mock-Up

The Contractor shall build a construction mock-up of every joint, juncture, and transition between materials, products, and assemblies of products specified in the different sections to be installed. Work will not begin until the mock-up is satisfactory to the Contracting Officer.

Mock-ups may be part of the permanent construction and shall shall demonstrate the proper installation sequence and workmanship required for the Air Barrier System installation to provide an airtight envelope conforming to the Performance Requirements specified in this Section. Select a representative locations for mock-up of each different condition found on the project, incorporating but not limited to the following:

a. Typical exterior wall with parapet
b. Wall air barrier system
c. Exterior cladding materials
d. Roofing
e. Roof air barrier system
f. Window, louver and door frame and sill
g. Air barrier seal around windows, door and louvers
h. Insulation
i. Flashing interface with air barrier system
j. Exterior wall corner conditions
k. Junction between exterior wall and roof systems
l. Junction between exterior wall and foundation
m. Typical construction, control and expansion joints
n. Typical penetrations and gaps; illustrating materials interface and seals.
o. Typical penetrations by structural members, conduits, electrical boxes, pipes and ducts.
p. Typical penetrations by masonry ties, screws, bolts and similar.

Any non-conforming mock-ups shall be corrected and become the standard of quality and construction for all subsequent similar conditions.

1.7.3 Coordination with Third Party Audit Agency

The Contractor shall coordinate with the Third Party Audit Agency performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. The Contractor shall notify the Third Party Audit Agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:

a. Provide access to the Work.

b. Furnish incidental labor and facilities necessary to facilitate inspections and tests.

c. Take adequate quantities of representative samples of materials that require testing or assist the third party audit agency in taking samples.

d. Deliver samples to testing laboratories.

e. Provide security and protection of samples and test equipment at the project site.

1.8 THIRD PARTY AUDIT AGENCY RESPONSIBILITIES

The third party audit agency engaged to perform inspections, sampling, and testing of the air barrier system materials, components, and assemblies specified throughout the different specification sections shall coordinate with the Contractor and the Contracting Officer. The third party audit agency shall notify the Contractor and the Contracting Officer of any irregularities or deficiencies observed in the Work during the performance of its services. The third party audit agency is not authorized to release, revoke, alter, or enlarge the requirements of the Contract Documents or approve or accept any portion of the Work. The third party audit agency shall not perform any duties of the Contractor.

1.9 SEQUENCING AND SCHEDULING

The Contractor shall coordinate between subcontractors required to provide an airtight building enclosure, customized fabrication and installation procedures and the following:

a. Continuity of the air barrier materials and products with joints to provide assemblies. Continuity of all the enclosure assemblies with joints and transition materials to provide a whole building air barrier system.

b. Specific quality control requirements for individual construction activities are specified in the sections of the specifications. Requirements in those sections may also cover production of standard products. It is the Contractor's responsibility to ensure that each subcontractor is adequately and satisfactorily performing the quality assurance documentation, tests, and procedures required by each section.

c. Specified inspections, tests, and related actions do not limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.

PART 2 PRODUCTS

The contractor/designer shall determine the appropriate type of air barrier product to be specified for the specific location and the permeability, Sheet, Fluid applied, Peel & stick etc. Air barrier locations shall include but not limited to;

a. Floor Slab On Grade Air/Vapor Barrier
b. Wall Air Barrier
c. Roof Air Barrier
d. Ceiling Air Barrier
e. Window, Door & Louver Air Barrier Seal

PART 3 EXECUTION

3.1 Repair and Protection

a. Take measures to protect the air barrier system from damage during construction.

b. Damaged air barriers shall be repaired as recommended by manufacturer by the air barrier installer prior to cover.

c. After completion of the building and upon completion of inspection and testing restore/repair any removed/damaged construction caused by finding and repairing leaks in the air barrier system and restore substrates, insulation and finishes to their original condition.

3.2 TESTING AND INSPECTION

The following qualitative and quantitative tests and inspections shall be conducted by the Contractor in the presence of the Contracting Officer during installation of the air barrier system.

Qualitative Testing and Inspection:

a. Provide a Daily Report of Observations with a copy to the Contracting Officer. The report shall confirm the following;

1. The continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

2. The structural support of the air barrier system can withstand design air pressures.

3. The masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.

4. Site conditions for application temperature, and dryness of substrates are within guidelines.

5. The substrate surfaces are properly primed.

6. Overlaps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied on exposed edges with no

fishmouths.

7. The mastic is applied on cut edges.

8. A roller has been used to enhance adhesion.

9. Measure application thickness of liquid applied materials to manufacturer's specifications for the specific substrate.

10. The correct materials are installed for compatibility.

11. Proper transitions for change in direction and structural support at gaps.

12. Ensure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

Quantitative Tests:

a. Provide written test reports of all tests performed with a copy to the Contracting Officer.

b. Determine the bond strength of coatings to substrate in accordance with ASTM D 4541.

3.3 BUILDING AIR TIGHTNESS TEST

Test the building for air tightness, following the Building Air Tightness Test Procedures. This test is intended to demonstrate that the building construction has produced an effective air barrier so that air infiltration and exfiltration are minimized. An adequate air barrier demands close attention to construction and installation of the building envelope components. For example, close attention must be paid to all seals, to sealant around window, door, and louver frames, to sealing of joints between panels, to sealing the wall-to-floor interface and especially to sealing the wall-to-roof interface.

a. The test shall be performed when the building envelope is enclosed and prior to the installation of the finished ceilings.

b. The contractor shall notify the Government at least 48 hours prior to the Building Air Tightness Test. A Government representative will witness the test and record test readings.

d. The measuring instruments used in the tests shall be digital meters, not analog gages.

e. The following conditions will be observed in the building during the testing:

(1) All exterior doors and windows shall be closed;
(2) All interior doorways including stairway doors shall be open;
(3) All HVAC systems shall be de-energized;
(4) All appliances shall be de-energized;
(5) All plumbing traps shall be full;
(6) The contractor shall prepare the building for testing in accordance with Section 4.5.2 of the USACE Test Protocol.

f. The contractor shall first test the building by pressurizing the building positively relative to outdoors at multiple pressures up to at least 0.30 in.w.g. (inches water gauge). From the positive pressure test, the building leakage rate shall be measured in accordance with USAC Protocol.

g. The Contractor shall then perform a negative pressure test at multiple pressures up to at least 0.30 in.w.g. and compare the results to the positive test. Where differences of 10% exist between the tests, the contractor shall investigate the causes and resolve the reasons for the differences. The Contractor shall retest the building.

h. The acceptable building air leakage is 0.04 CFM/SF cubic feet per minute per square foot maximum at a differential pressure of 0.3 in. w.g. If the building fails to meet the acceptable leakage rate, use techniques described in ASTM E 1186 to located the leak sources, then correct the deficiencies in the building construction, then retest. Fog agents used to identify leaks shall be the non-toxic type.

i. For each test, the contractor shall take a minimum of 12 readings at various pressures and air flows within the range of the calibrated equipment. In the test report, test points shall be shown in graphical form on a log-log scale with pressure in inches water column displayed on the horizontal axis and flow in cfm displayed on the vertical axis. A report shall be submitted for each leak test whether successful or not.

3.4 THERMOGRAPHY TEST

The building envelope shall be tested using Infrared Thermography technology. The thermography testing shall be completed in accordance with the requirements of ASTM C 1060 and ISO 6781 and the Building Air Thermography Survey Procedures The Contracting Officer shall witness the testing. The contractor shall note any areas of compromise in the building envelope, and shall note all actions taken to correct those areas. The thermography shall be used to demonstrate the problem areas have been corrected.

--End of Section--

CAPITAL IMPROVEMENTS

NAVFAC Naval Facilities Engineering Command

ENGINEERING & CONSTRUCTION Bulletin

Issue No. 2008-01 **13 December 2007** **Type: Guidance**

Subject: Energy Policy Act of 2005 Implementation and USGBC LEED® Certification

References: (a) Energy Policy Act (EPAct) of 2005 (Public Law 109-58), dated 8 August 2005
(b) Executive Order 13423: Strengthening Federal Environmental, Energy and Transportation Management, dated 24 January 2007
(c) US Green Building Council (USGBC) Leadership in Energy and Environmental Design Green Building Rating System for New Construction (LEED®-NC), Version 2.2, dated October 2005
(d) Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU), dated 24 January 2006
(e) Assistant Secretary of the Navy (Installations and Environment) Memorandum: Energy and Utilities Development in MCON and Special Projects, dated 4 August 2006
(f) American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE) and the Illuminating Engineering Society of North America (IESNA) Standard 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential

Attachments: (1) Energy Policy Act of 2005 Design and Construction Requirements
(2) MOU High Performance LEED® Credits
(3) Budget Cost for Energy Policy Act of 2005 and LEED® Silver Compliance

Cancelled: Engineering & Construction Bulletin (ECB) 2007-05: Energy Policy Act of 2005 Implementation, dated 26 January 2007

1. Purpose

Provide guidance for complying with the design and construction requirements of the Energy Policy Act (EPAct) of 2005, reference (a), and the Executive Order 13423, reference (b). Additionally, provide guidance on achieving LEED® Silver-level performance and USGBC certification described in reference (c).

2. Background

The EPAct of 2005, reference (a), includes design and construction requirements and energy performance standards for new Federal buildings. The provisions of the Act that affect design and construction are described in attachment (1).

Reference (b) was signed by the President on 24 January 2007. Section 2, paragraph (f), "Goals of Agencies", requires agencies to comply with the Guiding Principles of the Federal

Leadership in High Performance and Sustainable Buildings Memorandum of Understanding, reference (d).

The Assistant Secretary of the Navy (Installations & Environment) (ASN (I&E)) issued reference (e) directing Navy and Marine Corps Commanders, programmers and sponsors to "plan, program and budget for and meet the requirements of the Energy Policy Act of 2005, and policies noted". The memorandum includes a requirement to support achieving at least LEED® Silver-level rating performance.

The use of the LEED® rating system in the planning, design and construction of facilities can address and satisfy the requirements of the EPAct 2005 and the Executive Order. Credits that directly address the Guiding Principles of the 2006 MOU are identified in attachment (2).

Given the reporting requirements of references (a) and (b) there is a need for more accurate and accountable measurement than provided by self-certification. NAVFAC has determined that the USGBC LEED® certification process can provide cost effective assurance of achieving compliance with these requirements.

3. Policy & Implementation

Energy Efficiency
Reference (a) requires that new Federal buildings shall be designed to achieve energy consumption levels that are at least 30 percent below the levels established in the current ASHRAE Standard, reference (f), or the International Energy Conservation Code.

For major renovations where the work exceeds 50 percent of the building's plant replacement value (PRV), the designs shall achieve energy consumption levels that are at least 20 percent below the pre-renovation 2003 baseline if life cycle cost effective.

Water Conservation
For indoor water, after meeting the baseline Energy Policy Act of 1992 fixture performance requirements calculated for the building, employ strategies that use a minimum of 20 percent less potable water.

For outdoor water, employ water efficient landscape and irrigation strategies, including water reuse and recycling, to reduce outdoor potable water consumption by a minimum of 50 percent over that consumed by conventional means (plant species and plant densities).

FY08 Projects
NAVFAC FY08 construction projects have been funded without any programmed amount for compliance with EPAct 2005. Projects with design starts and Request for Proposal (RFP) preparations started on or after 3 January 2007 must comply with EPAct 2005 as codified under US Code 10 CFR 433 & 435, regardless of fund source.

If the project funding or life-cycle cost-effectiveness will not achieve the maximum energy efficiency goal of EPAct 2005, evaluate alternative designs at successive decrements below 30% to the optimal level that is life-cycle cost-effective. Do not decrease scope.

For Navy and Marine Corps projects, follow reference (c) for meeting LEED® Certified-level rating performance as the minimum goal for applicable projects. USGBC registration and certification of FY08 projects is recommended if attainable without decreasing scope and within allowable funds. To encourage higher levels of performance, include the following in Requests for Proposals:

> Design-Build projects: Include a technical evaluation factor for providing a facility that achieves a LEED® Silver-level rating performance.
>
> Design-Bid-Build projects: Include achieving a LEED® Silver-level rating performance as an additive bid item or option.

FY09 Projects and Beyond

All projects for new buildings and major renovations where the work exceeds 50 percent of the building's plant replacement value (PRV) must comply with EPAct 2005 requirements as codified under US Code 10 CFR 433 & 435, regardless of fund source, building size, location or temporary nature. Projects must also comply with the Executive Order 13423, reference (b). All projects must be registered with USGBC and have the required LEED® submittal documentation certified by USGBC to meet the required LEED® Silver-level rating.

Attachment (2) describes LEED® credits as minimum measures that conform to the Executive Order requirements above. For Navy and Marine Corps projects, follow reference (c) for meeting LEED® Silver rating, certified by the USGBC as the minimum requirement for new buildings and major renovations where the work exceeds 50 percent of the building's plant replacement value (PRV).

Building systems and features required for meeting the EPAct and sustainable development requirements will be included in the DD 1391, in accordance with guidance provided in attachment (3).

For FY09 MILCON projects, funds have been added to meet the requirements of EPAct, E.O. 13423, registration with USGBC and USGBC LEED® certification requirements. For new buildings procured by reimbursable, O&M, or funding other than MILCON, ensure there is adequate funding to register the project with USGBC and meet the USGBC LEED® submittal certification requirements

Scope and funding for FY10 projects and beyond must support the requirements of EPAct, E.O. 13423, registration with USGBC and USGBC LEED® certification requirements. Requirements will be identified as line items under "EPAct Compliance/LEED® Silver" in the DD 1391 Budget Estimate Summary Sheet and the total additional cost will be included in the "EPAct Compliance/LEED® Silver" line item in Box 9 of the DD 1391. For new buildings

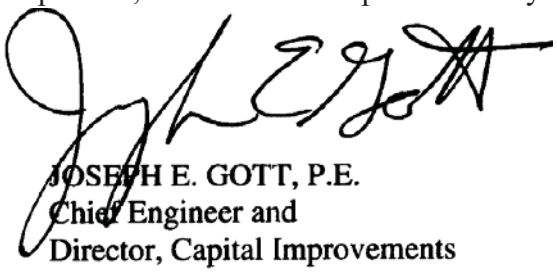
procured by reimbursable or Special Project funding, programmers must ensure there is adequate funding to meet the mandatory energy performance levels.

4. Action

This policy and implementation is effective immediately. Changes to criteria documents and NAVFAC standard contract templates to reflect this policy have been implemented. Project managers and contracting officers will ensure that all applicable contracts are in compliance with this guidance.

Capital Improvements will coordinate with the NAVFAC Acquisition Office to address policy issues related to final payment and contractor performance assessments.

This document has been reviewed by Headquarters, U.S. Marine Corps and is fully applicable to all USMC installations.



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Attachment (1)

Energy Policy Act 2005 Design and Construction Requirements

EPAct 2005, Section 103- Provide utility meters on all new federal buildings. Paragraph 2-6 of UFC 3-400-01 "Energy Conservation" currently requires metering of each utility serving the building.

EPAct 2005, Section 108 - Use recovered mineral components in concrete (fly ash, blast furnace slag, etc.). NAVFAC complies with this requirement with cement replacement materials and rates currently specified in the Unified Facility Guide Specifications.

EPAct 2005 Section 109 - All new federal buildings with designs started on or after January 3, 2007 must comply with EPAct 2005 Section 109 as codified by DOE under US Code 10 CFR 433 & 435. Specifically, all new federal buildings shall be designed to achieve energy consumption levels that are at least 30 percent below the levels established in the ASHRAE 90.1-2004 standard (for commercial or multi-family high rise buildings) or the 2004 International Energy Conservation Code (IECC, for residential buildings). If a 30% reduction level is not life-cycle cost (LCC) effective, alternative designs must be evaluated to achieve the most energy efficient level that is life-cycle cost-effective for that building.

This section applies to new buildings regardless of location, occupancy, size, funding source, client or temporary nature. Currently, Section 109 requirements do not apply to major renovations. If the 30% reduction level is not life-cycle cost-effective based on the analysis, the Designer of Record (DOR) shall use an iterative procedure, as described in the Rules and Regulations, Federal Register (Vol. 71, No. 232, Department of Energy, Office of Energy Efficiency and Renewable Energy), to find the lowest level of energy consumption that is life-cycle cost-effective. At no time shall the designed energy consumption level exceed the applicable standard: ASHRAE Standard 90.1-2004 or IECC.

EPAct 2005 Section 553- All energy using products or systems procured shall be Energy Star products or FEMP (Federal Energy Management Program) designated products. This affects built in and collateral equipment such as HVAC, lighting, transformers, office equipment, food service equipment, appliances, and all other energy consuming products. NAVFAC presently complies with this requirement through references in Unified Facility Criteria for mechanical and electrical equipment. Ensure these requirements are written into all contract scope of work statements including Category 3 & Category 4 projects.

Attachment (2)

MOU High Performance LEED® Credits

Executive Order: Strengthening Federal Environmental, Energy and Transportation Management, dated 24 January 2007, references the Memorandum of Understanding (MOU) on Federal Leadership in High Performance and Sustainable Buildings. The MOU represents a commitment by 21 federal agencies, including the Department of Defense, to reduce energy demands and employ appropriate sustainable design strategies that are life-cycle cost-effective. Specific goals and measures were identified in the MOU that typically have high return on investment. These goals and measures satisfy the requirements of the Energy Policy Act 2005 (EPAct).

To address requirements for the sustainable design of federal buildings, NAVFAC adopted the use of the USGBC LEED® Green Building Rating System. In Reference (d) direction was given to plan and program to achieve at least a USGBC LEED® Silver-level rating performance, a minimum of 33 LEED® credit points. The LEED® checklist is required on all projects to show credits being sought towards this goal. Include the checklist as an attachment to the Electronic Project Generator (EPG).

By aligning the MOU goals and measures with the LEED® system, 20 - 22 credit points can be achieved towards establishing the LEED® Silver-level rating, and satisfying the requirements of the EPAct. These credits are identified in the table below.

For all applicable projects (new buildings and major renovations where the work exceeds 50 percent of the building's plant replacement value (PRV)), use these credit strategies in meeting the LEED® Silver-level performance.

LEED®-NC version 2.2 Credits

Title	Credit	Number of LEED® Points
Employ Integrated Design Principles	N/A	0 points
Sustainable Sites		
Stormwater Design, Quantity Control	SS 6.1	1 point
Stormwater Design, Quality Control	SS 6.2	1 point
Water Efficiency		
Water Efficient Landscaping, Reduce by 50%	WE 1.1	1 point
Water Use Reduction, 20% Reduction	WE 3.1	1 point
Energy and Atmosphere		
Fundamental Commissioning	EAP	0 points
Optimize Energy Performance, 30% Reduction (EPACT 2005 Section 109)	EA 1	4 points (6 points for major renovations)
Enhanced Refrigerant Management	EA 4	1 point
Measurement and Verification	EA 5	1 point

Attachment (2)

MOU High Performance LEED® Credits

Materials and Resources		
Construction Waste Management	MR 2.1	1 point
Recycled Content, 10%	MR 4.1	1 point
Rapidly Renewable Products	MR 6	1 point
Certified Wood	MR 7	1 point
Indoor environmental Quality		
Low Emitting Materials	EQ 4	1 point
Thermal Comfort: Design	EQ 7.1	1 point
Daylighting	EQ 8.1	1 point
Innovation and Design Process		
Moisture Control Plan	ID 1	1 point
Bio-Based Products	ID 1	1 point
LEED® Accredited Professional	ID 2	1 point

Attachment (3)

Budget Cost for Energy Policy Act 2005 (EPAct) and LEED® Silver Compliance

EPAct 2005 requires energy consumption levels to be 30% less than current ASHRAE 90.1-2004 Standards. The budget to comply with this requirement was not included in FY07/08 projects but is included and detailed in all FY09 projects and should be included in FY10 and later projects.

Studies prepared by Steven Winter & Associates in the spring of 2006 examined three building types (Admin, BQ, & Maint. Fac.) to determine system requirements and costs to comply with the Energy Policy Act 2005. The facilities are located in the Norfolk, VA area (Mid Atlantic mixed-humid climate zone). The studies concluded that the required systems would have additional cost expected to be 1-3% of the Primary Facilities Cost (PFC) depending on the building type. Follow-on studies by Steven Winter & Associates are looking at four additional climate zones for the same three building types. The results from these studies should be available by December 30, 2007, with anticipation that the cost data can be included in the FY10 program as benchmarks.

In FY09 DD 1391 development, describe in the Budget Estimate Summary Sheet (BESS) the additional energy modeling, design studies, systems and features required for compliance with the EPAct 2005 and the Executive Order mandates, each with its own line item and price. Show the delta between the cost of the primary technology and the cost of the technology expected to be used to meet the requirements for EPAct 2005 and LEED® Silver. The documentation is not to show the cost by percentage increases. For the FY09 program, Block 9 of the DD 1391shall include a line item titled "EPAct 2005 & LEED® Silver Compliance". This line will be a summation of all cost deltas associated with the proposed technologies and features identified in the BESS to achieve EPAct 2005 and LEED® Silver compliance goals.

Typical technology types and features used to meet the new requirements include (but are not limited to): 1) High Efficiency Chillers, 2) Premium Efficiency Motors and Transformers, 3) Variable Air Volume (VAV) systems and Variable Speed Drive motors, 4) Occupancy Sensors, 5) Heat Recovery, 6) High Efficiency DX Air Conditioning Units, 7) Solar Water Heating, 8) Solar Walls, 9) Daylighting, 10) High Performance Windows, 11) High Albedo "Cool" Roof, 12) Radiant Heating, 13) Photovoltaic systems, & 14) Green roof. Appropriate to the climate zone where the project is located, the use of the listed technologies will vary. The project design team will determine the appropriate technology and any others as would be applied to the facility and climate zone.

Note that there are many design features and technologies that will help the project meet the LEED® Silver requirements but normally do not add cost. Those line items do not need to be listed in the BESS, but may be specifically identified in Block 10. Review blocks 10, 11, and 12 for any identified "sustainable" features. List only the major line items. Block 10 should include the standard Sustainability statement in every project.

Attachment (3)

Budget Cost for Energy Policy Act 2005 (EPAct) and LEED® Silver Compliance

To check the total cost of the programmed "Inhabited" Building against cost to comply with EPAct 2005 and LEED® Silver, confirm that the total cost delta is less than 3% of the Primary Facility Cost.

CAPITAL IMPROVEMENTS

NAVFAC Naval Facilities Engineering Command

ENGINEERING & CONSTRUCTION Bulletin

Issue No. 2008-02 **11 April 2008** **Type: Policy**

Subject: NAVFAC Red Zone Policy for Construction Contracts

1. Purpose.
To promulgate policy for facilitating effective and efficient construction completion, contract closeout, and turnover of NAVFAC constructed facilities to the Client. This NAVFAC Red Zone (NRZ) initiative focuses on planning and executing the actions required to render facilities complete and usable for timely turnover to the Client. NRZ also supplements aspects of facility turnover that are not included in the construction contract (e.g. NMCI, collateral equipment, etc.).

2. Background.
The success of any NAVFAC construction contract is determined by how well the facility supports the Client's mission and operational needs. The timely construction completion and turnover of a fully operational facility to the Client are important elements in achieving a high level of Client satisfaction. Each member of the project delivery team (Client, NAVFAC, and the contractor) has critical responsibilities to ensure timely completion and turnover of the new facility and each member should execute the NRZ process to achieve this end. The NAVFAC Project Manager (PM)/Design Manager (DM) has the lead to coordinate NRZ requirements in the RFP (Pre-award) and the Construction Manager (CM) has the lead to coordinate Facility Turnover Planning meetings and monitor the entire NRZ Checklist/Plan of Action and Milestones (POAM). NRZ focuses attention to details for a successful contract completion and turnover of the constructed facility.

3. Policy.
The NRZ process will be employed on NAVFAC construction contracts in accordance with BMS Process B-1.6.11 NAVFAC Red Zone. The NRZ initiative is focused on identifying all issues that could adversely impact contract completion and initial operating capability. The process addresses elements of construction completion, facility delivery activities, and contractor, Client, and NAVFAC actions. The process establishes business practices such as checklists, scheduling tools, meetings, and other tools to mitigate potential delays and costs and enable timely delivery of the completed project. Clear expectations for facility turnover will be established at the Post Award Kickoff meeting. The NRZ process will begin within the last 25% of contract time or three to six months before Beneficial Occupancy Date (BOD), whichever comes first, and extend to contract closeout.

4. Deployment.
All NAVFAC field activities will immediately implement this policy as prescribed in BMS process B-1.6.11. The PM/DM will incorporate NRZ requirements for contracts in Pre-award and the CM will incorporate meetings, checklists, and milestones on contracts that are awarded. The point of contact for this policy is Bob Silver bob.silver@navy.mil.

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CIME/tjh
01 March 2005

From: Commander, Naval Facilities Engineering Command, Capitol Improvements
To: Distribution

Subj: INTERIM TECHNICAL GUIDANCE (ITG) FY05-2, NAVFAC HUMID AREA HVAC DESIGN CRITERIA

Ref: (a) ITG FY03-4, "NAVFAC Mold Response Manual"
(b) Engineering Technical Letter (ETL) 04-3: Design Criteria for Prevention of Mold in Air Force Facilities, dtd 6 April 6 2004
(c) Engineering Technical Letter (ETL) 03-2: Design Criteria for Prevention of Mold in Air Force Facilities, dtd 12 August 2003

Encl: (1) "NAVFAC Humid Area HVAC Design Criteria," dtd 31 January 2005
(2) "Bachelor Housing 1 + 1E Apt Example"

1. Purpose. The purpose of this guide is to provide revised basic criteria and information concerning the design of facilities located in Humid Areas, with the intent to prevent the occurrence of mold and mildew growth.

2. Discussion. Reference (a) provides guidance on mold remediation and abatement, based upon increasing incidence of mold and mildew occurrence within Navy facilities. References (b) and (c) address prevention of similar problems within Air Force facilities. Enclosure (1) of this ITG incorporates substantial portions of the Air Force ETL, and supplements it with some additional information.

3. Action.

a. Design. All projects, located in Humid Areas, starting design 90 days after the effective date of this ITG will comply with enclosure (1). Projects currently under design shall be revised to comply, where schedule and funds permit.

b. Criteria. NAVFAC CI will coordinate the revision of existing and the drafting of new Unified Facilities Criteria (UFC) documents to incorporate the provisions of enclosure (1).

c. References to ITG FY05-02 have been added by changes to the following documents:

- UFC 1-200-01, *Design: General Building Requirements*
- UFC 3-410-0-02N, *Design: HVAC Systems*
- UFC 3-100-10N, *Architectural*
- UFC 3-400-10N, *Mechanical*

Subj: INTERIM TECHNICAL GUIDANCE (ITG) FY05-1, NAVFAC HUMID AREA HVAC DESIGN CRITERIA

Upon incorporation of Humid Area Design Criteria into existing and new documents, the above ITG FY05-02 and references to it will be cancelled.

4. Point of Contact. For clarification or additional information related to this subject, please contact Mr. Thomas J. Harris, PE, DSN 262-4206, Comm (757) 322-4206, email thomas.j.harris@navy.mil

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By direction

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01 March 2005

NAVFAC HUMID AREA HVAC DESIGN CRITERIA

1-1 Purpose. This guide provides design criteria for preventing mold inside Navy facilities.

1-2 "Humidity Control Basics." Successful control of humidity within Naval facilities, in order to prevent mold, requires the efforts of the several entities involved in the life cycle of the facility. The User must "Define the purpose of the project." The Architect must "Design a tight building." The HVAC designer must "Control the outdoor air." The Contractor must "Build low-leakage building and tight duct work." And the Building Operations Staff must "Maintain correct internal air pressure." Only then may the building meet the needs throughout the life cycle at minimum life cycle costs. The quotes courtesy of ASHRAE *Humidity Control Design Guide for Commercial and Institutional Buildings, Chapter 2,* see paragraph 3-1.4, below.

2-1 Application. This guide applies to new or renovated Navy facility projects that start design 90 days after the effective date of the ITG. Projects currently under design shall be revised to comply, where schedule and funds permit.

3-1 Referenced Publications:

3-1.2 Unified Facilities Criteria (UFC):
- UFC 3-400-02, *Design: Engineering Weather Data*
- UFC 3-400-10N, *Design: General Mechanical Requirements*
- UFC 4-721-10, *Design: Navy and Marine Corps Bachelor Housing,*

3-1.3 Unified Facilities Guide Specifications (UFGS):
- UFGS 15080, *Thermal Insulation for Mechanical Systems*
- UFGS 15950N, *Testing, Adjusting, and Balancing of HVAC Systems,*

3-1.4 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
- ASHRAE 52.2-1999, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*
- ANSI/ASHRAE 55-2004, *Thermal Environmental Conditions for Human Occupancy*
- ASHRAE 62.1-2004, *Ventilation for Acceptable Indoor Air Quality*
- ASHRAE 90.1-2004, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- Standard 90.1-2004 *User's Manual*
- *ASHRAE Fundamentals Handbook*
- ASHRAE *Humidity Control Design Guide for Commercial and Institutional Buildings*

3-1.5 Other Industry:
- National Roofing Contractors Association (NRCA) *Roofing and Waterproofing Manual* (fifth edition)
- International Code Council (ICC) *International Building Code 2003* (IBC)

4-1 Acronyms:

ANSI - American National Standards Institute
CFM - cubic feet per minute
CMS - cubic meter per second
F - Fahrenheit
HVAC - heating, ventilating, and air conditioning
ICC - International Code Council
MERV - Minimum Efficiency Reporting Value

5-1 Definitions:

5-1.1 Sensible Cooling Load: Heat gain that causes a change in dry bulb temperature at a constant humidity ratio.

5-1.2 Latent Cooling Load: The portion of the cooling load attributed to a change in the humidity ratio at a constant dry bulb temperature.

5-1.3 Humidity Ratio: The ratio of the mass of water vapor to the mass of dry air contained in a given moist air sample.

5-1.4 Humid Area (HA): Geographic location where UFC 3-400-02, Data Table (Page 1 of 18), Other Site Data, entry titled "Ventilation Cooling Load Index" indicates the annual latent cooling load (Ton-hr/cfm/yr) of outside (ventilation) air equals or exceeds three times the outside (ventilation) sensible cooling load, AND the monthly latent load exceeds the monthly sensible load, as evaluated by inspection of the graph (Page 14 of 18), titled "Average Ventilation and Infiltration Loads", for two or more consecutive months of the year.

6-1 Requirements.

6-1.1 Introduction. Navy facilities have experienced damage from moisture and/or mold, especially in locations within humid areas. The high ambient moisture and temperature common in high-humidity areas reverses vapor flow through building components and increases the latent cooling load on HVAC equipment, when compared to the design conditions for most other continental United States locations. These unique conditions require design criteria differing from the conventional wisdom used in other areas.

6-1.2 Site Drainage. Grade/slope building sites to drain away from buildings.

6-1.3 Building Envelopes. For new construction or renovation involving roofs and/or exterior walls, design and construction at all Navy locations in humid areas must comply with the following:

6-1.3.1 Continuous Air Barrier. Provide a continuous air barrier (vapor retarder, the least permeable material) on the exterior side of the building insulation and place only more-permeable materials on the interior side of the building insulation. For double-wythe walls,

place the continuous air barrier on the exterior side of the inner wythe. Provide drainage from the continuous air barrier to the exterior (i.e., weep holes in the base of the exterior brick veneer wythe, protected from accumulation of mortar droppings).

6-1.3.2 Moisture Seal. Seal all seams in the continuous air barrier, and seal all openings around doors and windows, lintels, utility penetrations, and at intersections of walls, roofs, floors, and foundation walls. Install non-permeable sill gaskets between floors and the bottom plate of exterior walls. Flash all windows and exterior doors with corrosion-resistant flashing to prevent water intrusion into the wall cavity. Provide design details in design drawings for these requirements. Provide details to minimize thermal bridging, especially at door and window frames and the intersections of walls and roofs. Refer to *Humidity Control Design Guide for Commercial and Institutional Buildings,* Chapter 2, "Humidity Control Basics" for more information.

6-1.3.3 Provide roof/ceiling/insulation systems complying with the following principles:

6-1.3.3.1 Install the continuous air barrier (vapor retarder) in accordance with guidance in the *NRCA Roofing and Waterproofing Manual* (fifth edition).

6-1.3.3.2 Ventilate spaces created outside the roof/ceiling continuous air barrier (vapor retarder). For sloped roofs, ventilation must comply with the *International Building Code 2003* (IBC), Section 1202.2. Ensure that moisture transfer from ventilated attics into the building is minimized the same as for walls.

6-1.3.3.3 Prohibit entry of unconditioned outside air into all spaces inside the thermal envelope. Ventilation of such spaces, if required, must use air from conditioned spaces.

Exception: Mechanical, Electrical, Elevator Machine, and similar rooms, provided with louvers or other intended means of outside air entry, shall have all the interior surfaces provided with a continuous air barrier, except the interior face of the exterior walls. Walls and ceilings may be painted with vapor retardant paint, and above-grade floors may be seal-coated concrete.

6-1.3.3.4 On the interior face of exterior walls, use only interior wall finishes that allow water vapor within the wall to escape into the conditioned space, such as latex paint. Vinyl wall coverings, oil-based paint, and other vapor-resistant materials will not be used as interior finishes for exterior walls.

6-1.3.4 Envelope Design Analysis. For swimming pool enclosures, museums, and other highly-humidified buildings, the designer must perform a moisture/vapor diffusion analysis for exterior walls and roof structures, using the dew point method as shown in American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) *Fundamentals Handbook* (Fundamentals), 2001, Chapter 23 using design weather conditions as stated in paragraph 6-1.4.1.1 of this document. The wall analysis must indicate any planes of condensation. Acceptable wall design shall either NOT contain any planes of condensation or the walls SHALL have the capability to drain/vent the moisture to the exterior (i.e., weep holes). Corrective action (i.e., redesign) must occur if the design fails to meet these requirements.

6-1.4 HVAC Systems:

6-1.4.1 HVAC System Cooling/Dehumidification Capability. For facilities authorized air conditioning, HVAC system cooling/dehumidification capacity must be designed to meet the following:

6-1.4.1.1. Outside Design Conditions for all locations. Refer to UFC 3-400-02 and utilize the Design Criteria Data available from the referenced Air Force Combat Climatology Center website. For Design/Build projects, the data may be defined in the RFP documents.

6-1.4.1.1.1. Cooling Systems:

Humid Area Facilities, Specialized De-humidification Systems, and 100% Outside Air Systems: For design, use the "1% Occurrence" value of outside air "Dry Bulb Temperature (T)" "Design Value (°F)" and the "Mean Coincident (Average) Values" "Wet Bulb Temperature (°F)" for the Design Cooling Day. Also, design for Maximum Humidity conditions, using the "1.0% Occurrence" value of outside air "Humidity Ratio (HR)" "Design Value (gr/lb)" and the "Mean Coincident (Average) Values" "Dry Bulb Temperature (°F)." For Mission-Critical Facilities in Humid Areas, use the "0.4% Occurrence" values instead of the "1% Occurrence"values above.

Mission-Critical Facilities (not HA), where equipment failure due to high heat would be unacceptable: For design use the "0.4% Occurrence" value for outside air "Dry Bulb Temperature (T)" "Design Value (°F)" and the "Mean Coincident (Average) Values" "Wet Bulb Temperature (°F)" for the Design Cooling Day.

Other Typical Facilities and Systems (not HA): For design, use the "1% Occurrence" value of outside air "Dry Bulb Temperature (T)" "Design Value (°F)" and the "Mean Coincident (Average) Values" "Wet Bulb Temperature (°F)" for the Design Cooling Day.

Cooling Towers or Evaporative Cooling Equipment: For sizing, use the "0.4% Occurrence" (for Mission-Critical Facilities) or the "1.0% Occurrence" (for Other Typical Facilities) value for outside air "Wet Bulb Temperature (T)" "Design Value (°F)" and the "Mean Coincident (Average) Values" "Dry Bulb Temperature (T)" for the Design Cooling Day.

6-1.4.1.1.2 Heating Systems:

Mission-Critical Facilities: For design, use the "99.6% Occurrence" value for outside air "Dry Bulb Temperature (T)" "Design Value (°F)."

Other Typical Facilities: For design, use the "99.0% Occurrence" value for outside air "Dry Bulb Temperature (T)" "Design Value (°F)."

6-1.4.1.2 Inside Design Conditions for Bachelor Housing, Administrative Spaces, and Family Housing:

6-1.4.1.2.1. Cooling Systems:

Space Design conditions shall be 76 Fdb (24.4 Cdb) & 50% RH, during the Design Cooling Day outside air conditions. At all other than design day, occupied times, maintain the space within the "Summer" conditions shown in ASHRAE *Handbook of Fundamentals – 2001*, Chapter 8, Figure 5, but not less than 76 Fdb (24.4 Cdb). Space thermostat typically set at 76 Fdb +/- 2 Fdb dead band (24.5 Cdb +/- 1 Cdb). 100% Outside Air systems shall operate continuously in Humid Areas, to prevent mold growth.

Admin spaces with Process cooling; Space Design conditions are to be determined by the requirements of the respective processes to be utilized within.

Note: Spaces authorized comfort cooling shall be designed for inside temperatures no lower than 76 Fdb (24.4 Cdb). During unoccupied hours, cooling systems shall be secured where appropriate. [IAW OPNAVINST 4100.5D]

6-1.4.1.2.2. Heating Systems:

Space Design conditions shall be 70 Fdb (21.1 Cdb) during the Design Heating Day outside air conditions. At all other than design day, occupied times, maintain the space within the "Winter" conditions shown in ASHRAE *Handbook of Fundamentals – 2001*, Chapter 8, Figure 5, but not more than 70 Fdb (21.1 Cdb). Space thermostat typically set at 70 Fdb +/- 2 Fdb dead band (21.1 Cdb +/- 1 Cdb).

Admin spaces with Process heating; Space Design conditions are to be determined by the requirements of the respective processes to be utilized within.

Note: Spaces requiring comfort heating shall be maintained at temperatures no higher than 70 Fdb (21.1 Cdb). During unoccupied hours, temperatures shall be set no higher than 55 Fdb (12.8 Cdb). [IAW OPNAVINST 4100.5D]

6-1.4.1.3. Inside Design Conditions for Laboratories, Shops, Warehouses, etc:

Space Design conditions, during the Design Heating Day outside air conditions, shall be 65 Fdb (18.3 Cdb) for areas with moderate activity employment, 60 Fdb (15.5 Cdb) for areas with heavy activity employment, and 50 Fdb (10 Cdb) for storage areas.

Spaces with Process heating; Space Design conditions are to be determined by the requirements of the respective processes utilized within.

Note: Temperatures shall be maintained to minimize energy consumption, with 55 Fdb (12.8 Cdb) being the maximum for heating purposes in storage spaces. [IAW OPNAVINST 4100.5D]

6-1.4.2. System Design. Provide HVAC systems to separately dehumidify and precondition ventilation air if the latent cooling load at the design weather condition causes a system reheat requirement to maintain space conditions (if total dehumidification were to be accomplished by

the system cooling coil). The HVAC systems must provide the capability to condition ventilation air and maintain space relative humidity less than 60 percent over the full range of cooling load. Where a separate system is provided to treat outdoor air, the system must comply with 6-1.4.8.1.2 below.

6-1.4.3 Psychrometric Design Analysis. The HVAC design analysis for new facilities or renovation of existing facilities must include a psychrometric analysis of each system, documenting that the system design meets the criteria in paragraph 6-1.4.1. The analysis must provide calculations of system cooling loads (sensible and latent); coil selections; fan selections; chiller or refrigeration system selections; and a system psychrometric diagram and table, indicating state point conditions of dry bulb, wet bulb, and dew point temperatures, humidity ratios, enthalpy, and relative humidity of outside air, mixed air, supply air, and return air flow streams.

6-1.4.4 Equipment Compliance. Construction specifications will require HVAC equipment submittals documenting that proposed equipment is in compliance with the design.

6-1.4.5 Ventilation Air. Supply ventilation air to satisfy ASHRAE 62-2004, *Ventilation for Acceptable Indoor Air Quality*, for the number of occupants, or as required to meet exhaust air requirement plus 15 percent for pressurization, whichever is larger. Ventilation air must be 115 +/- 5 percent of exhaust air for all spaces with direct mechanical exhaust.

Exception: Ventilation for military family housing is normally satisfied by infiltration or natural ventilation, and is designed per Energy Star requirements.

6-1.4.6 Filtering. Filter ventilation air before it enters an air handler, heat recovery equipment, or preconditioning equipment. Use extended media filters with a Minimum Efficiency Reporting Value (MERV) of 7 or greater, in accordance with ASHRAE 52.2-1999, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.*

6-1.4.7 Duct Seal. Seal all ducts to SMACNA Seal Class B, and leak test in accordance with UFGS 15950N, *Duct Air Leakage Testing (DALTS).* Ducts shall also be sealed at all penetrations through the building enclosure and continuous air barrier, and at all connections to equipment, louvers, registers, and grills. Registers and grills shall also be sealed to the space interior wall surfaces. Louvers shall be sealed to exterior wall surfaces. Seal all seams within the air paths, including within air moving equipment. Where units or ducts penetrate the exterior wall, seal all thru-wall sleeves between the exterior wall and the sleeve at both the exterior and interior wall surfaces. Also, seal all thru-wall sleeves between the units and ducts and the sleeve, at the exterior end of the sleeve. Seal all curb-mounted rooftop HVAC equipment to the roof curbs, and seal the roof curbs to the roofing membrane. Seal all HVAC equipment mounted within the building envelope to the supply and return ducts, to prevent leakage from or into the building cavities. Duct insulation must be external; duct board or internal duct liner are not allowed. Use only metal ductwork for the central ventilation and exhaust systems.

Supply air duct leakage into the building cavities causes condensation, leading to mold growth within the cavities, and reduced cooling to the spaces. Exhaust air duct leakage depressurizes the

building cavities, increasing infiltration of moisture laden outside air into the building cavities, leading to mold growth within the cavities, and reduced removal of moisture laden or pollution laden air intended to be exhausted.

6-1.4.8 Bachelor Housing and Navy Lodge Facilities.

6-1.4.8.1 New Facilities. The design must provide sufficient floor-to-floor height, vertical distribution space, and mechanical equipment space to accommodate ducted systems to supply preconditioned ventilation air, and ducted systems for exhaust air. **In these types of facilities, do not use the space above the ceiling as an HVAC plenum.**

6-1.4.8.1.1 Within bathrooms, the substrate beneath ceramic tile, plastic tile, or plastic finished wall panels in areas exposed to water (e.g., tub and shower enclosures) must be made of cement, fiber cement, or composite materials manufactured specifically for use in high-moisture locations.

6-1.4.8.1.2 Ventilation Air Supply (VAS) Systems. New facilities must employ separate, dedicated, constant-volume, central ventilation air supply systems that continuously supply dehumidified and reheated (tempered) 100 percent outside air to all occupied spaces. The design intent of these systems is not to provide total space heating and cooling, but to provide total ventilation load and space latent load cooling, and to capture any available VAS sensible cooling to meet a portion of the space sensible cooling load; systems must continuously condition and deliver ventilation air to each occupied space. The ventilation air must be dehumidified to maintain a 55 F dew point (Fdpt) (12.8 C dew point (Cdpt)) and reheated (tempered) enough to maintain ventilation air supply relative humidity less than 70% within VAS ducts. This reheat is to reduce potential for mold growth within the VAS ducts due to moisture carryover from the cooling coil. VAS supply air temperature must not be at or below room design dew point temperature, to avoid condensation on the supply air registers. VAS supply air dew point temperature must be below room design dew point temperature, in order to meet the room latent load. Humidification of ventilation air during periods of low ambient humidity is not required, unless otherwise indicated. Facility central VAS systems must not be subject to intermediate season (no-heat/no-cool) shutdown, or any other non-emergency shutdown. Individual room heating/cooling equipment must have occupant control, but may be subject to intermediate season heating/cooling curtailment as directed by local command. Systems must be designed to minimize the transmission of sound between apartments. The designer will provide a psychrometric analysis documenting that the system is designed to properly maintain the space temperature and relative humidity, at the required "0.4% or 1 % Occurrence" Outside Design Conditions. The system must provide the capability to condition ventilation air and maintain space relative humidity less than 60 percent over the full range of cooling load.

Note: Conditioning of ventilation air is not required for facilities not otherwise air-conditioned.

6-1.4.8.1.3 Exhaust Systems. A central ducted bathroom exhaust system will be used instead of individual exhaust fans for each space. The exhaust system must run continuously and be interlocked with the building supply air system. The exhaust duct for each space must have a manual volume damper accessible from the space for proper balancing. Install an exhaust grille, constructed of corrosion-resistant material, just outside each shower stall and bathtub. Exhaust

systems must be designed to minimize the transmission of sound between apartments. Exhaust from moisture-producing equipment (i.e., clothes dryers) must be vented to the exterior. Take advantage of the ASHRAE allowed reduced bathroom (toilet) ventilation requirements due to provision of continuous operation; see 2001 ASHRAE Handbook Fundamentals, Chapter 26, Table 3.

Note: Vent-less Clothes Dryers are not acceptable in Humid Area locations.

6-1.4.8.1.4 Air Balance for Bachelor Housing. Continuous VAS of 15 cfm (0.007 cms) per person for 4 persons (maximum) wartime loading will be 60 cfm (0.0028 cms). Continuous bathroom exhaust of 20 cfm (0.009 cms) (ASHRAE recommendation) will allow the remaining 40 cfm (0.019 cms) to pressurize the spaces to reduce infiltration. The bathroom will dry a little more slowly with the continuous exhaust airflow, but the VAS at 55Fdpt (12.8 Cdpt) will ensure that it dries satisfactorily. Bedrooms and kitchen spaces will remain dry due to pressurization reducing infiltration loads from humid outside air during door openings. Clothes dryer operation (if provided) will temporarily create an additional 150 cfm (0.071 cms) exhaust flow, which will be satisfied by the 40 cfm (0,019 cms) VAS pressurization air flow plus 110 cfm (0.052 cms) of infiltration, during the approximately one hour drying cycle. The other 23 hours of 40 cfm (0.019 cfm) exfiltration of VAS will transport the infiltrated moisture back outside the space, thereby protecting these spaces from moisture accumulation and resultant mold growth.

6-1.4.8.1.5 Heat Recovery. Use heat recovery from exhaust air, or from VAS refrigeration equipment, to provide the VAS reheat and reduce the energy consumption necessary to condition ventilation air, where savings from heat recovery results in a life cycle cost payback for the heat recovery equipment.

6-1.4.8.1.6 Economizer Cycle. Economizer cycle will not be used in Navy construction, unless required by ASHRAE Standard 90.1 (STD 90.1). Full use of the STD 90.1 Economizer Requirements Exceptions shall be taken, to avoid economizer use, where allowed. These exceptions are detailed in the 90.1 User's Manual, Section 6.3.1. They include the weather & capacity exception (Table 6.3.1); the residential exception, the envelope-dominated exception; the High efficiency exception, and others. STD 90.1, Table 6.3.1, lists 1% Cooling Design Wet Bulb Temperature (CDwbt) ranges and the Number of Hours the Outside Air Design Dry Bulb Temperature is between 55 Fdb (12.8 Cdb) and 69 Fdb (20.5 Cdb), during the time period of 8 AM to 4 PM. The tabulated value is the minimum system size that **will** require an economizer. STD 90.1, Appendix D-1, lists values for the 1% CDwbt and No. of Hours for many locations. Engineering Weather Data (EWD) lists the 1% Cooling Wet Bulb Temperature, on page 1 of 18, and lists the Dry Bulb Temperature Hours For An Average Year, on page 9 of 18. The column labeled "Hour Group (LST) 09 to 16" may be used to obtain the number of hours for use in STD 90.1, Table 6.3.1. The difference between the STD 90.1, Appendix D-1 data and the EWD is small, and is due to the difference in hours included in the data. STD 90.1 uses 0800 through 1559; EWD uses 0900 through 1659. Use the EWD data where available.

6-1.4.8.1.7 Storage Spaces. Closets and storage or utility rooms smaller than 4.64 square meters (50 square feet) of floor space within conditioned spaces must have undercut and overcut doors

allowing airflow through these spaces. Closets and storage or utility spaces larger than 4.64 square meters of floor space must be supplied with conditioned air.

6-1.4.8.2 Existing Facilities. Existing facilities being renovated must incorporate ventilation air supply systems as described for new facilities in paragraph 6-1.4.8.1.2. Where the facility structure (i.e., floor-to-floor height) prohibits dedicated central ventilation air systems, alternative system (package unit) designs must have separate, dedicated, and continuous conditioning of ventilation air. The designer will perform a psychrometric analysis documenting that the system is designed to maintain space humidity with entering ventilation air at the 1 percent humidity ratio design weather condition. The system must provide the capability to condition ventilation air and maintain space relative humidity over the full range of cooling load.

6-1.4.9 HVAC Equipment Selection.

6-1.4.9.1 For VAS cooling coils, typically with a depth of 4 or more rows, indicate the design coil fin density on the equipment schedules, not to exceed a maximum of 8 fins per inch (8 fins per 25.4 millimeters), to ensure a cleanable coil and competitive bidding. For other than VAS cooling coils, with typical depth of less than 4 rows, indicate the cooling coil fin density on equipment schedules at a maximum of 14 fins per inch (14 fins per 25.4 millimeters). To preclude moisture carryover, coil face velocities must not exceed 550 feet per minute (167.6 meters per minute). Ultraviolet lights may be considered to control growth of mold within the coil, air-handling unit, and ductwork, and may be especially suitable for use with deep (4 row or more) cooling coils.

6-1.4.9.2 Specify the minimum number of cooling coil rows in the equipment schedules. The number of rows will be based on a comparison of data from at least three manufacturers and must ensure that latent cooling loads can be met or exceeded.

6-1.4.9.3 Cooling coil design entering and leaving air conditions must be specified (wet and dry bulb temperatures) at the design airflow rate.

6-1.4.9.4 Select equipment with a cooling capacity closest to the design load (no safety factors) meeting the conditions of paragraph 6-1.4.1. Over-sizing the cooling equipment inhibits dehumidification capability. (Heating equipment capacity SHOULD INCLUDE appropriate safety factors.)

6-1.4.9.5 Several options for equipment types are available to accomplish dehumidification. Select equipment that will meet the design requirements and provide the lowest life cycle cost and energy consumption.

6-1.4.10 HVAC System Layout.

6-1.4.10.1 To the maximum extent possible, chilled water piping must be routed through pipe chases and hallways. Avoid concealing piping in the walls or ceilings of occupied spaces. Provide access for maintenance.

6-1.4.10.2 Insulate piping with an operating temperature below dew point with jacketed insulation meeting the cold piping requirements of UFGS 15080, *Thermal Insulation for Mechanical Equipment.* The insulation jacket must be sealed to provide an exterior vapor barrier.

6-1.4.10.3 Sufficiently sized, safe access must be provided for the maintenance of valves, variable air volume (VAV) boxes, dampers, controls, and other HVAC components.

6-1.4.10.4 Ductwork must not be installed within or beneath slab-on-grade floors.

6-1.4.11 Design Analysis Submittal. The designer shall provide a single submittal package, for approval of the Contracting Officer, including each of the following applicable Design Analysis (DA):

ITG Paragraph 6-1.3.4.	Envelope DA
ITG Paragraph 6-1.4.3.	Psychrometric DA
ITG Paragraph 6-1.4.8.1.2.	VAS Psychrometric DA
ITG Paragraph 6-1.4.8.2	Existing Facility Alternative System Psychrometric DA

7-1 Testing, Adjusting, and Balancing (TAB). HVAC systems will be tested, adjusted, and balanced to verify and document actual performance of the systems and evaluate conformity with the design intent. UFGS 15950N will be used to develop the contract requirements for TAB.

8-1 Point of Contact. Recommendations for improvements to this ITG are encouraged and should be furnished to:

Commander, Naval Facilities Atlantic,
Engineering and Criteria Office (Code CI),
6506 Hampton Blvd., Norfolk, Virginia 23508-1278,
Attn: Mr. Thomas J. Harris

Or contact Mr. Harris at DSN 262-4206, (757) 322-4206, Fax (757) 322-4416

Or email to thomas.j.harris@navy.mil

BACHELOR HOUSING
1 + 1 E Apt
Example

Design Space Conditions: 76 Fdb, 50%RH, 56 Fdpt, 67 grHR (Design values underlined)

Occupancy: 2 + 2 persons, per UFC 4-721-10, Chap. 4-6 and 10-33.

Minimum Outside Air = 4 persons X 15 CFM/person = 60 CFM, per ASHRAE STD 62

Exhaust Air (EA) Reqmts: Bathroom – 20 CFM continuous, per ASHRAE Fund C26, Table 3
Or Bathroom – 50 CFM intermittent, per ASHRAE Fund C26, Table 4
And Clothes Dryer – 150 CFM intermittent, per ASHRAE Fund C26.18

Ventilation Air Supply (VAS) = greater of Minimum Outside Air for occupants (60 CFM)
Or 115% of Exhaust Air (20 CFM X 115% = 23 CFM), per UFC 4-721-10, Chap. 6.4.5
Or 115% of Exhaust Air (50 CFM X 115% = 57.5 CFM), per UFC 4-721-10, Chap. 6.4.5

Choose VAS = 60 CFM and Continuous Bathroom Exhaust = 20 CFM

This leaves 40 CFM available for pressurization, to reduce infiltration, and to dissipate, during 23 hours per day of exfiltration, the moisture infiltrated when the clothes dryer operates for say 1 hour per day.

Calculate Space Latent Load and Sensible Load due to occupants; all other sensible loads to be taken by the space cooling and heating equipment:

Male seated typing 4 persons X 255 BTUHL = 1020 BTUHL
4 persons X 255 BTUHS = 1020 BTUHS

Latent Load (BTUHL) = 0.68 X CFM X Δ grHR; rearranging to Δ grHR = BTUHL/ 0.68 CFM

Therefore: Δ grHR = 1020 BTUHL / (0.68 X 60 CFM) = 25 grHR

VAS HR Conditions must be Space HR (67 gr) – (25 gr) = 42 grHR

Therefore: The VAS cooling coil leaving conditions are about 47.7 Fdb, 46.3 Fwb, 45.1 Fdpt, & 42 grHR.

To maintain the VAS 70% RH in ductwork requirement of the ITG, Encl. (1), 6.4.7.1.1, reheat is needed to obtain a VAS reheat coil leaving conditions of 54.6 Fdb, 70 %RH, 49.5Fwb, 45.1 Fdpt, & 42 grHR.

Sensible Load (BTUHS) = 1.08 X CFM X Δt Fdb; rearranging to Δt Fdb = BTUHS/1.08 X CFM

Therefore: Δt Fdb = 1020 BTUHS / (1.08 X 60 CFM) = 15.75 Fdb

Therefore: Space temperature without other sensible loads would be VAS reheat coil leaving conditions of 54.6 Fdb + 15.75 Fdb = 70.35 Fdb.

Adding in the estimated sensible load from the refrigerator of 375 BTUHS raises the room temperature as follows:

Δt Fdb = BTUHS/1.08 X CFM = 375 BTUHS / (1.08 X 60 CFM) = 5.75 Fdb

Therefore: Space temperature with the 4 persons and the refrigerator will be 70.35 Fdb + 5.75 Fdb = 76.1 Fdb.

All other sensible loads will be taken by the space HVAC equipment, such as the outside wall load, the interior corridor or mechanical chase load, the fenestration load, and the various internal loads, such as lights, cook-top, microwave, ceiling fan motor, washer/dryer, and personal items such a televisions, computers, etc.

Consider now only 2 persons in the apartment:

VAS still 60 CFM; Space Latent Load = 510 BTUHL, Space Sensible Load = 510 BTUHS

Δ grHR = BTUHL/ 0.68 CFM = 510 BTUHL / (0.68 X 60 CFM) = 12.5 grHR

Δt Fdb = BTUHS/1.08 X CFM = 510 BTUHS / (1.08 X 60 CFM) = 7.9 Fdb

VAS HR Conditions must be Space HR (67 gr) – (12.5 gr) = 54.5 grHR

Therefore: The VAS cooling coil leaving conditions are about 52.8 Fdb, 51.4 Fwb, 50.4 Fdpt, & 54.5 grHR.

To maintain the VAS 70% RH in ductwork requirement of the ITG, Encl. (1), 6.4.7.1.1, reheat is needed to obtain a VAS reheat coil leaving conditions of 62.4 Fdb, 70 %RH, 55.4 Fwb, 50.3 Fdpt, & 54.5 grHR.

Therefore: Space temperature without other sensible loads would be VAS reheat coil leaving conditions of 62.4 Fdb + 7.9 Fdb = 70.3 Fdb; with refrigerator heat added, it will be 70.3 Fdb + 5.75 Fdb = 76.1 Fdb.

Therefore, the VAS/Exhaust systems need to sense the building room average conditions, and reset the VAS cooling coil and VAS reheat coil-leaving conditions, based upon occupancy.

Consider a Relative Humidity or Dew point sensor sensing the building total bathroom EA airflow dew point, and averaging it over several hours, and controlling the VAS cooling coil control valve to open upon a rise in EA dew point, and to close upon a fall in EA dew point. By averaging over a long period of time, the influence of showers, and clothes washing are damped out, and the system responds to the long-term building occupancy driven latent load. This will

maintain the VAS cooling coil-leaving dew point at the desired value to maintain the space conditions.

Consider a Thermostat sensing the building total bathroom EA temperature, and averaging it over several hours, and controlling the reheat coil control valve to close upon a rise in EA temperature, and to open upon a fall in EA temperature. By averaging over a long period of time, the influence of showers, and clothes washing are damped out, and the system responds to the long-term building occupancy driven sensible load. This will maintain the VAS reheat coil leaving temperature at the desired value to avoid overcooling the spaces under low load conditions.

This control scheme attempts to minimize the VAS cooling use of new energy while protecting the building and contents from mold. It also attempts to use the reheat to minimize new energy use in the space cooling equipment, while not over-cooling the spaces under low load.

Both the VAS and EA Systems must run continuously in order to protect the building from mold and mildew growth. Even if the building is to be vacated, these systems still need to run continuously. However, with no occupancy, it may be possible to slow down the VAS and EA system fan speeds, so as to deliver less airflow to the building, without losing control of the space dew point.

BUILDING AIR LEAKAGE:

From UFC 4-721-10, Design: Navy and Marine Corps Bachelor Housing, Chapter 4, Para. 4-3, the Gross Building Area per Apartment = 710 sq. ft. Assuming a minimum height of 9 feet from top of floor to top of floor, and a three-floor building, the volume of the building may be approximated by the following:

Bldg. Volume = Area x Height = 710 sq. ft. x 100 units x 9 ft. high = 639,000 cubic feet.

The design VAS (outside air) volume to be delivered is 60 cubic feet per minute (CFM) per unit. Therefore, the total VAS is as follows:

VAS vol. = 60 CFM x 100 units x 60 min. per hour = 360,000 cubic feet per hour (CFH)

The design Exhaust Air (EA) volume to be removed by the toilet exhaust is 20 CFM per unit. Therefore, the total EA is as follows:

EA vol. = 20 CFM x 100 units x 60 minutes per hour = 120,000 CFH

Therefore, the design air change rate, available to offset building air leakage, is the (VAS volume minus EA volume) divided by the building volume, as follows:

(VAS – EA) / Bldg. Vol. = (360,000 – 120,000) CFH / 639,000 cubic feet
= 0.38 Air Changes/ hour

Per the ASHRAE *Humidity Control Design Guide for Commercial and Institutional Buildings,* Chapter 16, Building Pressure Management, based upon a field investigation survey of 70 commercial buildings in the southern U. S., these buildings leaked an average of 0.4 AC/hr when the HVAC systems were OFF, and an average of 0.9 AC/hr when the HVAC systems were ON. It is easy to see that the available 0.38 AC/hr will not be enough to positively pressurize the building with properly dehumidified VAS, unless and until we construct a building envelope tighter than the average, and we construct the HVAC system ductwork tighter than average. Additionally, the 60 CFM per unit was based upon 4 persons per unit, not the normal 2 persons per unit, therefore, the design VAS volume is ample, and the design EA volume is as low as allowed by ASHRAE.

The only other means to keep the moisture that leads to mold and mildew out of the building is to increase the VAS CFM enough to offset the leakage. This requires larger, more expensive HVAC equipment, greater energy consumption, and greater maintenance costs, for the life of the building.

Investing in sealing the building enclosure, and sealing the HVAC system, will avoid these increased life cycle costs.

CAPITAL IMPROVEMENTS

NAVFAC Naval Facilities Engineering Commar

ENGINEERING & CONSTRUCTION Bulletin

Issue No. 2010-05 **8 July 2010** **Type: Policy**

Subject: **Solar Roof Technologies for Use on Marine Corps New Construction and Roof Replacement Projects**

Reference: (a) Assistant Deputy Commandant I&L (Facilities) Memorandum, Roofing System Design and Construction for MILCON Building Projects and Major FSRM Roof Replacements, 16 OCT 2009
(b) Assistant Deputy Commandant I&L (Facilities) Memorandum, Roof Design for New Construction and Major Renovations – Change 1, 3 MAR 2010
(c) Public Law 110-112, Energy Independence and Security Act of 2007, 19 December 2007

Attachment (1) Design Guidance, Instructions for filling out DD1391, Criteria, and Best Management Practices for Roof Top Solar Thermal, Photovoltaic, and other Energy Saving Features

1. Purpose

Provide the NAVFAC planning and design community with guidance for implementing Marine Corps policy established in references (a) and (b) requiring solar technologies be incorporated in (1) new building construction, and (2) major building renovations involving complete roof replacements. The Marine Corps is relying on NAVFAC as its principal design and construction agent, to identify and implement measures to maximize the use of solar energy generation and technology within their facilities.

2. Background

The best time to install a solar thermal and/or photovoltaic system is during new construction or complete roof replacement. Incorporating solar technologies into the design and construction of buildings on Marine Corps installations reduces the carbon footprint, provides a hedge against volatile energy costs, and makes a visible environmental statement.

3. Applicability

This ECB applies to (1) new construction and major renovation projects beginning with the POM 2012 MILCON program, and (2) Facility Sustainment, Restoration and Modernization (FSRM) projects beginning in FY10, where design requirements do not substantially impact project execution. Marine Corps Community Service (MCCS) is enjoined to comply with this guidance where feasible.

The policy established in references (a) and (b) cannot be used to solely justify a roof replacement. For Host Nation funded construction, similar technology shall be pursued within established agreements and where feasible.

4. Policy

Similar to safety, security, and building access requirements, solar energy generation shall be considered a design scope requirement for new construction and complete roof replacement projects. Meeting the provisions of the policy established by references (a) and (b) must be in accordance with applicable Building Codes and Unified Facility Criteria (UFCs) for structural, mechanical, electrical, and roofing. The following provisions shall be incorporated into the planning and design of Marine Corps buildings:

- All new construction and major renovation projects requiring complete roof replacements will incorporate roof top solar thermal and/or photovoltaic systems.
  - For FSRM projects, solar thermal and photovoltaic technologies shall be classified as "construction" and are subject to the $750K congressional approval threshold.
- Energy Star reflective roof products shall be used in combination with roof-top solar thermal and photovoltaic systems unless determined by the installation to be exorbitantly cost prohibitive or not technically feasible. White roofs shall be used on flat or low slope portions of the roof, and considered on sloped portions of the roof where aesthetics is not a concern and will not impact heat load in adjacent buildings.
- Vegetative roofing systems shall be considered on a case-by-case basis.
- Ground mounted photovoltaic systems shall be considered where available roof area is less than 15,000 square feet and/or improperly oriented for maximum solar use.
- DD Form 1391 instruction, design criteria, and best management practices are provided in attachment (1).

5. Waivers

There are two waiver paths to these requirements, (1) technical waivers, and (2) mission/operational waivers.

1. Technical waivers and exceptions related to the design, construction and modification will be submitted to NAVFAC Headquarters, Office of the Chief Engineer (CHE) via the NAVFAC component chain of command.
2. The Installation Commanding Officer can grant mission and operations waivers related, but not limited, to inadequate building orientation, extreme climate conditions, historic preservation requirements, and extraordinary costs to install the solar feature.

6. Points of Contact:

For Marine Corps Energy Policy: Mr. Scott Houldsworth, Energy Program Manager Facilities Branch, HQMC LFF, (703) 695-6158 x3252 (DSN 225).

For NAVFAC Energy and Sustainability Policy and Guidance: Mr. Scott Mauro, P.E., NAVFAC HQ CI, Chief Engineer's Office, (202) 685-9280 (DSN 325).

This document has been reviewed by Headquarters, U.S. Marine Corps and is fully and immediately applicable to all USMC installations.

JOSEPH E. GOTT, P.E.
Chief Engineer and
Director, Capital Improvements

Design Guidance, Instructions for filling out DD1391, Criteria, and Best Management Practices for Roof Top Solar Thermal, Photovoltaic, and other Energy Saving Features.

A. Solar thermal hot water systems, where appropriate, shall be the first priority. Reference (c) establishes a minimum of 30% of the hot water demand in new buildings be met using solar hot water, provided it is life-cycle cost effective. Solar thermal systems will be designed in accordance with UFC 3-440-04N, Solar Heating of Buildings and Domestic Hot Water.

B. Rack Mounted Photovoltaic Systems

Maximize the generation of renewable electricity through available photovoltaic technology. The following is provided as integration guidance:

- Use a rack mounting system designed to allow ease of access for roof maintenance and repair personnel.
- Install systems with a southern orientation to the maximum extent practicable.
- Install flash penetrations in accordance with National Roofing Contractors Association (NRCA) guidance.
- Minimize shading from foliage, vent pipes, or adjacent structures.
- Minimize electrical losses (wiring, over current, switches, inverters).
- Properly ground systems to reduce the threat of shock hazards and induced surges.
- Design and manage battery housing as a roof system component, if applicable.
- Interconnect with the utility company (following accepted procedures).
- Produce utility quality electrical output.
- Incorporate an insulated 3 ply modified bitumen roof membrane with factory applied light colored mineral granular surfacing to address increased maintenance foot traffic for low sloped roofs (less than 3 inches per foot to 0.5 inches per foot minimum).
- Use self-ballasted rack systems where practicable, to avoid damage to the roof's watertight membrane.
- Use rack-mounted photovoltaic systems in lieu of thin film laminate systems on low slope roof applications. Thin film (TF) laminate systems are not recommended at this time. While the future of TF laminate systems is promising, they are currently experiencing operational problems which include ponding, sediment accumulation, incomplete UL fire rating classifications, single ply membrane delamination, and advanced deterioration. If a Marine Corps installation does desire to use thin-film solar PV material, then NAVFAC HQ CI shall be consulted.
- Use rack mounted systems on steep slope roofs (slope > 3 inches per foot).
- Determine the site and economic feasibility of using ground-mounted photovoltaic systems in combination with, or as an alternative, to roof mounted systems during project planning and design.

C. Reflective Coatings

Use energy-saving reflective or Energy Star® roof coatings unless determined to be exorbitantly cost prohibitive or not technically feasible in combination with roof-top solar thermal and/or photovoltaic technologies. Consider energy-saving reflective or Energy Star® coated modified bitumen roof coating where roof insulation does not meet (R) = 20 minimum per ASHRAE 90.1-2007 and where roof traffic is minimal and not shaded.

Attachment (1)

- Use white roofs on flat or low slope roofs.
- Raised or highly visible white roofs will, over time, show dirt which impacts building aesthetics. The use of reflective coatings on raised roofs shall be considered for standing seam metal roofs and coordinated with the USMC installation to ensure all architectural, energy, and maintenance issues are documented and addressed.

D. Day Lighting

Use day lighting techniques when technically feasible and cost effective for energy conservation.

E. Vegetative Roofing

Consider vegetative roofing systems for storm water mitigation, energy conservation and acoustical benefits. Vegetative roofing systems shall be integrated with the planning and design requirements of UFC 3-210-10, Low Impact Development. When Marine Corps installations are located in arid and high wind environments, all structural, operation and maintenance requirements shall be considered. Extensive vegetative roofs are recommended, since they are more cost effective, less complex, and require less maintenance (compared to intensive vegetative roofs). Vegetation will be selected based on sustainability and compatibility with the site's natural environment.

F. Other Sustainable Technologies

Use other sustainable technologies and Energy Star products as appropriate and life cycle cost effective (ex. recycled materials and insulation components).

G. Life Cycle Cost Analysis

Use of above listed solar technologies is directed, as required scope, and not discretionary based on life cycle cost effectiveness. Life cycle cost analysis can be used to optimize the mix of solar thermal and photovoltaic systems. Links to some cost effectiveness tools can be found at:
https://portal.navfac.navy.mil/portal/page/portal/che/che_communities/che_communities_mechanical/cime_project_team_tab

H. MILCON

- Provide line item cost estimate for solar thermal and/or photovoltaic system in DD1391, Block 9. Use local cost data where available (note: average costs for FY10 projects were approximately $32.00/square feet).
- Ensure total project square footage includes additional building components and spaces such as water tanks and battery storage areas.
- Maximize Leadership in Energy & Environmental Design (LEED) Green Building Rating System points obtained under EA Credit 2, On-Site Renewable Energy.

STORMWATER AT CAMP LEJEUNE, **NORTH CAROLINA**

1. Camp Lejeune is located in Onslow County, North Carolina. Onslow County is a coastal county. Camp Lejeune is located in the White Oak River Basin.

2. New projects at Camp Lejeune must be designed to meet the Coastal Stormwater Rules that went into effect in October, 2008. To access the Rules go to the Division of Water Quality web site, http://h2o.enr.state.nc.us/. Under "Stormwater Runoff & Non-point Source Pollution" click on Coastal Stormwater Rules. For the specific design requirements of the Coastal Rules click on Session Law 2008-211, Senate Bill 1967. (Direct link: http://www.ncleg.net/Sessions/2007/Bills/Senate/HTML/S1967v4.html)

   If the project is a modification to an existing stormwater permit or redevelopment, please check with the Division of Water Quality, Wilmington Regional Stormwater Staff to determine design criteria.

3. In order to design a stormwater plan, one must know the classification of the water body that the project drains to. USGS Quad Sheets are helpful in determining the name of the stream that the project drains to. Camp Lejeune appears on the following Quad Sheets: Sneads Ferry, Camp Lejeune, New River Inlet, Hubert, and Jacksonville South. The Division of Water Quality has a web site that gives the Classification and index numbers of streams, http://h2o.enr.state.nc.us/bims/reports/reportsWB.html. To identify which section of the waterbody the project site drains to, it helps to sort the waterbodies hydrologically instead of alphabetically.

4. New projects that increase the amount of built upon area (BUA) within the project area are considered to be either a high density project or a low density project. High density projects are those projects that drain to surface waters classified as non-SA and have over 24% BUA or projects that are within ½ mile of and drain to waters classified as SA and have over 12% BUA. All stormwater runoff from high density projects must be treated using an engineered stormwater treatment measure (BMP) designed to remove at least 85% of total suspended solids.

5. At Camp Lejeune, a "permit boundary" must be established in order to determine density. That permit boundary must be identified on the plans and include bearing and distances. Note: since the base is thousands of acres in size, property lines are not used for the purpose of determining density.

6. Detailed guidance for designing BMPs can be found on the extremely useful Division of Water Quality BMP web site, http://h2o.enr.state.nc.us/su/bmp_forms.htm. The BMP manual includes the requirements from Section 1008 of the Stormwater Rules in the Major Design Elements table provided in the individual BMP chapters. In addition to reviewing the chapter for the individual BMPs, it can also be helpful to read Chapters 3 and 5 for basic stormwater calculations and common BMP design elements. Stormwater treatment measures that do not appear in the BMP Manual have not yet been approved for use in North Carolina.

7. For determining the 1-yr, 24-hr storm event rainfall depth and intensity, the NOAA web site is very helpful. The link is on the BMP web site, but can also be accessed here: http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nc_pfds.html. In order to obtain information for the 1-yr, 24 hr storm event, select the option for the partial duration time series. For Camp Lejeune, the 1-yr, 24-hr rainfall depth is typically 3.8 inch while the intensity is 0.15 inch/hour.

8. If engineered BMPs (wet pond, infiltration system, bioretention, etc) or curb outlet swale systems are proposed, a soils report with detailed soils information is required to be submitted with the application package. This report is based upon fieldwork at the site, typically conducted by a soil scientist. Please note that The SHWT elevation is not the same thing as the groundwater elevation typically reported in geotechnical reports.

   The soils report should contain the estimated **seasonal high water table (SHWT) elevation** at each proposed BMP location and should be reported in FMSL, not as a depth below the existing ground. If the soils report does provide the SHWT as a depth, the bore map must include the existing ground elevation at each boring. For infiltration systems and open-bottom sand filters, the report should include the soil type and expected infiltration rate at each proposed BMP location.

   For projects proposing an infiltration system, the SHWT elevation must be field-verified by the State's Soil Scientist. If an infiltration system is proposed, please request a copy of the Infiltration Site Visit Request form from the Stormwater Staff in the Wilmington Regional Office. Once the completed form and soils report have been submitted to the Wilmington Regional Office, DENR's soil scientist will schedule a site visit. A consultant involved in the soils analysis must be present during the site visit.

9. The submittal package will need the stormwater application form as well as the applicable supplements and operation and maintenance (O&M) agreements, which are also located on the BMP website. One supplement and one O&M agreement must be submitted for each BMP. The only exception to this is the level spreader and filter strip O&M, where one may be submitted for the entire site.

   When printing out the supplement, remember to print out and complete Section III, the Required Items Checklist, which is located on a separate sheet of the electronic supplement file.

10. It is strongly recommended that the designing engineer review the Application Review Checklist, which is also located on the BMP website, prior to submittal. This document is currently being updated, however the current version will provide a good overview of what DWQ looks for in the submittal packages.

11. Federal and Coastal wetlands must be identified on project sites by a qualified wetland specialist. Wetland delineation(s) must be drafted onto the plans. It is recommended that the federal wetland delineation from an independent source be verified/certified by the Corps of Engineers and the coastal wetland delineation be field verified by the Division of Coastal Management. If there are no wetlands on the project area, include a note on the plans stating that there are no wetlands along with the name/title of the individual who made the determination. See the Application Checklist for other features that must be on the plans such as streams, mean high water and required buffers.

12. The review fee for a stormwater application package in the regular stormwater program is $505.00. The application package may be mailed in to the Wilmington Regional Office for review. Two folded blueprint plans or plan sets and one original application, supplements, O&M, and calculations plus the check - made payable to NCDENR- are required. Please refer to the Submittal Requirements listed on the application for additional requirements.

    There is also an Express Review option available. The review fees for the Express Program are based upon the type of project. For example, the fee for a low density project review is $2,000 while a high density project is $4,000. In the Express program, the application submittal must be scheduled and the submittal must be done in person. For more information or to schedule a submittal meeting through the Express Program, contact the Express Coordinators, Janet Russell at janet.russell@ncdenr.gov. or Cameron Weaver at cameron.weaver@ncdenr.gov. The DENR permitting contact for Camp Lejeune is David Towler on base. David can be reached at 910 451-3238 ext. 3284 or by email at david.towler@usmc.mil.

American Warrior Network

Need a 2" conduit with pull string from the telecomm room assigned with wall space for the commercial provider to a Hand hole out side the building.

Building wiring should be CAT6 with a minimum of two cables per faceplate. There should be 2 faceplates per user on opposite walls, for example a two occupant room would have 4 faceplates. Tele/Comm outlet faceplates shall be standard double gang box with single gang reducer and 1¼ inch conduits stubbed into a basket tray in hallway ceiling. Basket tray should feed from a comm. room on the same floor or one floor above or below via 4" sleeves / conduit. Number of sleeves / conduit should be calculated using fill ratios from **TIA-569-B.**

Face plate will contain two RJ-45 jacks per faceplate with 2 CAT 6 cables going back to 110 fields in the comm. room. Contact AWN Tussey, Michael A for any questions Michael.A.Tussey@sprint.com.

Use Siemon's CT couplers, CT-F-C6-C6-20 for faceplates or equivalent equipment approved by AWN.

Ensure a back board per comm. room is available for AWN –Backboard shall be 8'H x 4'W x ¾" A/C grade plywood with two coats of fire retardant paint. Ensure there is access to base telephone's Telecommunications Main Grounding Bus bar (TMGB) for any bonding. TMGB should be (4 inches by min 10 inches by ¼ inch thick copper) pre drilled with a minimum #6 green sheathed stranded wire double lug connected and crimped extended from the electrical main distribution panel and building steel.

Labeling shall be in accordance with industry standards which includes room # and port # in the room (building number is not needed). Provide a complete "as built" floor plan with location of all ports and numbering on ports in .dwg and .pdf format to base telephone and AWN.

Install additional backboards in the comm. room to allow mounting of AWN cable head and lightning protection at demark point for OSP cabling. All conduit should be in accordance with MCB Camp Lejeune Telephone Specifications Section 27 10 00 and MCB Camp Lejeune Telephone Specifications Section 33 82 00.

Also unless otherwise stated current base tele specs 27 10 00 will apply along with all references it contains. If you have questions contact Base tele at 910-451-9439 /4760

SECTION 22 14 00.00 22

RAINWATER HARVESTING
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(1999; Addenda A 2000, Addenda B 2001; R 2004) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2010) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2008) Performance Requirements for Atmospheric Type Vacuum Breakers (ANSI approved 2009)
ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1011	(2004; Errata 2004) Performance Requirements for Hose Connection Vacuum Breakers (ANSI approved 2004)
ASSE 1012	(2009) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent - (ANSI approved 2009)
ASSE 1013	(2009) Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers - (ANSI approved 2010)
ASSE 1020	(2004; Errata 2004; Errata 2004) Performance Requirements for Pressure Vacuum Breaker Assembly (ANSI Approved 2004)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the

Examination of Water and Wastewater

AWWA B300 (2010) Hypochlorites

AWWA B301 (2010) Liquid Chlorine

AWWA C651 (2005; Errata 2005) Standard for Disinfecting Water Mains

AWWA C652 (2002) Disinfection of Water-Storage Facilities

AWWA C700 (2009) Standard for Cold Water Meters - Displacement Type, Bronze Main Case

AWWA C701 (2007) Standard for Cold-Water Meters - Turbine Type for Customer Service

ASME INTERNATIONAL (ASME)

ASME A112.1.2 (2004) Standard for Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)

ASME B1.20.1 (1983; R 2006) Pipe Threads, General Purpose (Inch)

ASME B40.100 (2005) Pressure Gauges and Gauge Attachments

ASME BPVC (2010) Boiler and Pressure Vessels Code

ASTM INTERNATIONAL (ASTM)

ASTM B 117 (2009) Standing Practice for Operating Salt Spray (Fog) Apparatus

ASTM B 370 (2009) Standard Specification for Copper Sheet and Strip for Building Construction

ASTM C 920 (2011) Standard Specification for Elastomeric Joint Sealants

ASTM D 2822 (2005) Asphalt Roof Cement

ASTM E 1 (2007) Standard Specification for ASTM Liquid-in-Glass Thermometers

ASTM E 2129 (2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual (1988e9) Manual of Cross-Connection Control

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2009) International Plumbing Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2009) Motors and Generators
NEMA MG 11	(1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2009; Errata 09-1) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF/ANSI 61	(2010a) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01	(2004) Firestopping: Plastic Pipe in Fire Resistive Construction

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2009) Hose Clamp Specifications

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 50.12	National Primary and Secondary Ambient Air Quality Standards for Lead
PL 109-58	Energy Policy Act of 2005 (EPAct05)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section [01 33 00 SUBMITTAL PROCEDURES][01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES]:

[SD-02 Shop Drawings

Rainwater harvesting System; G

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Detail drawings for the complete rainwater harvesting system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.]

[Modular Storage Tank; G

Detail drawings showing the size, configuration, and other information to illustrate the requirements and assembly of the storage tank modules and all required accessories. Provide storage tank drawing plans, elevations, views, and details drawn to scale.]

[Fiberglass Reinforced Plastic Storage Tank; G

Detail drawings showing the size, configuration, and other information to illustrate the requirements and assembly of the storage tank modules and all required accessories. Provide storage tank drawing plans, elevations, views, and details drawn to scale.]

SD-03 Product Data

[Local/Regional Materials

Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

[Environmental Data]

Materials

Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Fixtures; (LEED)

List of installed fixtures with manufacturer, model, and flow rate.

Rainwater Control System[; G]

[Modular Storage Tank; G]

[Fiberglass Reinforced Plastic Storage Tank; G]

Submersible Feed Pump[; G]

Debris Filter[; G]

Initial Runoff Filter[; G]

Rainwater Sediment Filters[; G]

Rainwater Ultraviolet Purification System[; G]

[Dye Injection System[; G]]

[Chlorine Injection System[; G]]

[Unpressurized Holding Tank[; G]]

[Booster Pump[; G]]

[Packaged Pump System[; G]]

Hydropneumatic Tank[; G]

Backflow Preventers[; G]

Domestic Water Service Meters[; G]

Vibration-Absorbing Features[; G]

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

Rainwater Harvesting System; G

Diagrams, wiring diagrams for power, signal, and control wiring, dimensioned outline drawings of equipment and system, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of the rainwater harvesting system including piping, tanks, pumps, and controls.

SD-06 Test Reports

Tests, Flushing and Disinfection

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Test of Backflow Prevention Assemblies; G.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

SD-07 Certificates

Materials and Equipment

Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

SD-10 Operation and Maintenance Data

Rainwater Harvesting System; G

Submit in accordance with Section [01 78 23 OPERATION AND MAINTENANCE DATA][01 78 24.05 20 FACILITY OPERATION AND MAINTENANCE SUPPORT INFORMATION].

1.3 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein.

1.3.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.3.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 REGULATORY REQUIREMENTS

Unless otherwise required herein, all work shall be in accordance with ICC IPC. Energy consuming products and systems shall be in accordance with PL 109-58 and ASHRAE 90.1 - IP. In addition, energy consuming equipment shall have the Energy Star label.

1.6 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

1.9 SUSTAINABLE DESIGN REQUIREMENTS

1.9.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [500][_____] mile radius from the project site, if available from a minimum of three sources.

1.9.2 Environmental Data

[Submit Table 1 of ASTM E 2129 for the following products: [_____].]

1.9.3 Rainwater Harvesting System

Provide a sustainable design technique of rainwater harvesting. To achieve Low Impact Development (LID) and LEED credit(s), provide a complete rainwater harvesting and management system complete ready for use. The

system shall be complete and shall serve plumbing fixtures within the facility in accordance with LEED guidance. The system shall collect, treat, store, and distribute rainwater as "non-potable water" in sufficient capacity to achieve the corresponding water efficiency reduction for LEED credit(s). The system shall be provided in accordance with the most stringent requirements from the applicable government criteria, including the requirements/recommendations of the following:

o EPA Manual "EPA/625/R-04/108 September 2004, Guidelines for Water Reuse" Web link is http://www.epa.gov/nrmrl/pubs/625r04108/625r04108.pdf

o NCDENR Technical Guidance Stormwater Treatment Credit for Rainwater Harvesting Systems, web link is http://h2o.enr.state.nc.us/su/documents/RainwaterHarvesting_Approved.pdf

o The Texas Manual on Rainwater Harvesting, latest edition, web link is www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf

North Carolina Rules Regarding Water Reuse, See North Carolina ADMINISTRATIVE CODE Effective April 1, 2001. Pages 31 - 36 of 44. See also ENR-ENVIRONMENTAL MANAGEMENT COMMISSION T15A: 02H .0200.

All of the water closets, urinals[,_____], and hose bibbs shall be served by non-potable water. To distinguish non-potable water from potable water, the non-potable water shall be [dyed with a purple color (Pantone 522) and]embossed or integrally stamped or painted "CAUTION: RECLAIMED WATER - DO NOT DRINK". Provide this notice at all hose bibbs connected to the rainwater harvesting system. The non-potable water piping system shall have its own particular identification color and pipe ID code/name. The identification color shall be in accordance with local codes. The non-potable water system shall have a potable water back-up for supplement during dry spells. Provide potable water back-up via air gap or reduced pressure back-flow preventer and a pressure reducing station with level controls in accordance with the plumbing codes, NC building code, NCDENR requirements, North Carolina Administrative Code, and EPA requirements.[Provide drainage of cooled condensate to rainwater collection system.]

PART 2 PRODUCTS

2.1 MATERIALS

The requirements for pressure piping and fittings are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Material or equipment containing lead shall not be used in the rainwater harvesting system. Rainwater collection piping located outside the building shall be as specified in Section 33 40 00 STORM DRAINAGE UTILITIES.

2.1.1 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Copper, Sheet and Strip for Building Construction: ASTM B 370.

b. Asphalt Roof Cement: ASTM D 2822.

c. Hose Clamps: SAE J1508.

d. Hypochlorites: AWWA B300.

e. Liquid Chlorine: AWWA B301.

f. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.

g. Thermometers: ASTM E 1. Mercury shall not be used in thermometers.

2.1.2 Pipe Insulation Material

Insulation shall be as specified in Section [23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS][23 07 00.00 22 MECHANICAL INSULATION].

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment. Except as specified herein, valves are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Pressure ratings shall be based upon the application. Valves shall conform to the following standards:

Description	Standard
Ball Valves Threaded, Socket-Welding, Solder Joint Ends	MSS SP-110
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Pressure Reducing Valves	ASSE 1003

2.4 BACKFLOW PREVENTERS

Backflow preventers shall be approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Provide reduced pressure principle type assembly backflow preventers on each in-coming potable service water line to the rain water harvesting system. In addition, provide backflow preventers in accordance to the North Carolina Building Code and the Water Supply permit. All backflow preventers shall be accessible. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR Manual. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.5 RAINWATER HARVESTING SYSTEM

Provide the rainwater harvesting system complete with all components necessary to provide a complete system to collect, store, and process rainwater for use in situ; including water treatment as appropriate to intended service. System shall include the following items:

2.5.1 Rainwater Control System

Provide a rainwater control system capable of monitoring and controlling the entire rainwater harvesting system. The system shall be able to monitor the water level in the cistern storage tank, the status of the filters, and the purification system. The system shall control the cistern pump and the bypass connection to the potable water supply to ensure a continuous water supply to the building fixtures connected to the system.

2.5.2 Modular Storage Tank

Storage tank shall be composed of interlocking modular sections arranged in the configuration shown on the civil drawings. The modules shall be assembled from injection molded plastic top, bottom, and side panels of the manufacturers standard size. The top and bottom panels shall be connected by either extruded rigid PVC columns or internal baffles. The tank structure shall be capable of withstanding HS-20 surface loads as defined by AASHTO. Provide inspection ports, inlets, outlet, and overflow connections as shown on the Plumbing and Civil drawings. Tank shall be vented to atmospheric pressure.

2.5.3 Fiberglass Reinforced Plastic Storage Tank

Storage tank shall be fiber glass reinforced plastic (FRP) Underground Storage tank. Provide a polyester resin chemical rated coating on the tank (interior and exterior). Tanks shall be capable of handling internal pressure loads of 5 psig pressure with a 5:1 safety ratio. The tank size shall be as indicated on the Plumbing and Civil drawings. Tank shall be leaked test in the factory at 5 psig. The tank shall be capable of withstanding a vacuum test to 11.5 inches of mercury. The tank shall be capable of withstanding surface loads from H-20 axle loads. The tank shall be capable of handling external hydrostatic pressure loads from being buried in the ground up to seven feet overburden with a safety factor of 5:1 against general buckling. Tank shall be designed, rated, and ASME BPVC code stamped. The tank and all components, and accessories shall be manufactured with materials conforming to the requirements of NSF standard 61

Provide the tank with a vent to the atmosphere. The tank shall be manufactured with 100% resin and glass fiber reinforcement. Provide FRP anchor straps. Provide as recommended and specified by the tank manufacturer all the required types and number of anchors, strap locations, strap sizes, and number of straps.

With the tank provide the following FRP accessories with all necessary supports: Internal pump platforms, drop and fill downcomer tubes, submersible pumps[and ladders], flanged manways[(minimum of two)], Manway extensions, and covers.

2.5.4 Submersible Feed Pump

Provide a submersible pump for the rainwater storage tank. The pump shall be capable of providing the flow quantities at the conditions indicated on the drawings. Pump motor shall be the high efficiency type. The pump shall be rated for potable water and shall have the required certifications and shall be NSF listed for the service intended. Provide the pump with a floating type extractor with screen and a float type level control to shut down the pump when tank level is below safe level for pump operation.

2.5.5 Debris Filter

Provide a self cleaning type debris filter to remove trash before rainwater is delivered to the storage tank. The filter is to be provided as a self contained unit with inlet, outlet, and overflow pipe connections, and removable stainless steel 0.35 mm mesh[basket] strainer. Provide an adjustable dome shaft with pedestrian load rated cover. Provide the cover with a child proof closure.

2.5.6 Initial Runoff Filter (Water Diverter)

Provide an initial runoff filter (water diverter) to remove water borne contaminants. The filter shall consist of a horizontal underground chamber sized as indicated on the Plumbing drawings, to hold the initial water runoff from the roof. Provide a floating ball at the filter inlet to divert water to the storage tank once the chamber of the initial runoff filter is full. At the outlet end of the filter provide an adjustable orifice that slowly allows the water in the chamber to drain out over time. The orifice shall be removable for servicing.

2.5.7 Rainwater Sediment Filters

Provide 50 and 10 micron sediment filters, and a 10 micron carbon filter sized for the service intended and located as shown on the drawings. The filters shall have removable filter housings with replaceable cartridge type filters and shall be NSF listed for the service intended.

2.5.8 Rainwater Ultraviolet Purification System

Provide a ultraviolet water purifier sized for the service intended and located as shown on the drawings. The unit shall be NSF listed for the service intended.

[2.5.9 Dye Injection System

Add description here.

][2.5.10 Chlorine Injection System

Add description here.

][2.5.11 Unpressurized holding Tank

Add description here.

][2.5.12 Booster Pump

Pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump and motor shall be[integrally mounted on a cast-iron or steel subbase,][close-coupled with an overhung impeller,][and][supported by the piping on which it is installed]. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze. The pump shall be UL listed, rated for potable water, shall have the required certifications, and shall be NSF listed for the service intended and meet the requirements of NSF/ANSI 61. The pumps shall be selected for maximum energy efficiency.

Motor shall be high efficiency type and totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover.

Integral size motors shall be premium efficiency type in accordance with NEMA MG 1. Pump motors smaller than 1 hp Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Guards shall shield exposed moving parts.

][2.5.13 Packaged Pump System

The package pump system for the rainwater harvesting shall be a dual vertical multistage pump system with variable frequency drives (VFD), electronic controller to maintain a constant discharge pressure, pump control valves, and pressure reducing valves. The pumps shall be selected for maximum energy efficiency. The electronic controller shall be a programmable controller with keypad and LCD display. Programmable functions shall include but not limited to: Pump status, Standby designation, elapsed running hours, system pressure set point, actual system pressure, VFD pump speed percent, VFD pump min and max speed, system faults, pump priority, pump rotation order, friction loss compensation, high and low discharge pressure shut down limits and alarms, low suction pressure shut-down limit and alarm, clock program, DDC control input and output for connection into the DDC system. Pump package shall be UL listed. Components shall be certified with manufacturer certified ratings. All electrical components, devices, and accessories of the pump package shall be listed and labeled as given in NFPA 70. Pump motors shall be high efficiency type and totally enclosed fan cooled. The pump shall be rated for potable water and shall have the required certifications and and shall be NSF listed for the service intended.

]2.5.14 Hydropneumatic Tank

Provide Tank specifically designed for use on potable water systems with size and acceptance volume shall be as indicated on the drawings. Construct of steel for minimum working pressure of125 psig. Tank shall have polypropylene or butyl lined diaphragm which keeps the air charge separated from the water. Provide ASME code stamped tank in accordance with ASME BPVC.

2.6 DOMESTIC WATER SERVICE METERS

Cold water meters 2 inches and smaller shall be positive displacement type conforming to AWWA C700. Cold water meters 2-1/2 inches and larger shall be turbine type conforming to AWWA C701. Meter register may be round or straight reading type, indicating with totalizer. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories. The water meters shall be connected to the DDC system for remote reading of all water usage. Provide water meters for the make-up water to the rainwater harvesting system and the rainwater supply to the water distribution system in the locations as shown on the Plumbing drawings.

2.7 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00

INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide[high efficiency type,] single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11.[In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide polyphase, squirrel-cage medium induction motors with continuous ratings, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.] Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart.

Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.8 MISCELLANEOUS PIPING ITEMS

2.8.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.8.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors.

2.8.2.1 Sleeves in Masonry and Concrete

Provide schedule 40 steel or PVC plastic pipe sleeves. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.8.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.8.3 Pipe Hangers (Supports)

Provide MSS SP-58 and MSS SP-69, Type 1 with adjustable type steel support

rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

2.8.4 Nameplates

Provide 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 0.25 inch high normal block lettering into the white core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The rainwater harvesting system shall be installed complete with necessary equipment, fittings, valves, and accessories. Rainwater harvesting system piping shall be extended 5 feet outside the building, unless otherwise indicated. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Rainwater harvesting system pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the[average local frost depth][finish grade] or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body. All piping located below the building shall be supported from above by the floor slab. Provide adequate working space around all equipment in accordance with manufacturers written requirements. Working space shall allow room to perform maintenance functions as well as to pull coils, pumps, heat transfer surfaces, valves and valve operators, dampers, controls, control wiring, conduit fans, motors, etc.

3.1.1 Water Pipe, Fittings, and Connections

Water pressure piping, fitting and connections to the rainwater harvesting system and equipment shall be made in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE. Rainwater collection piping located outside the building shall be connected in accordance with Section 33 40 00 STORM DRAINAGE UTILITIES.

3.1.1.1 Utilities

The piping shall be extended to all fixtures and equipment. The rainwater

harvesting piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, hydrants, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the materials and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough

to allow for expansion without straining.

3.1.2 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.2.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.2.2 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.4 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.4.1 Sleeve Requirements

Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand

and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.

Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.

Unless otherwise indicated, sleeves shall be of a size to provide a minimum of [1/4 inch][one inch] clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.

Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and[concrete][masonry] wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.1.4.2 Flashing Requirements

The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes, up to and including 10 inches in diameter, passing through floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.4.3 Pipe Penetrations of Slab on Grade Floors

Where pipes, or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.4.4 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.5 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

3.1.6 Supports

3.1.6.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.6.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Section 23 05 48 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in[Section 05 12 00 STRUCTURAL STEEL][Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.1.6.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron steel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC pipe shall be 120 degrees F for PVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 4 inches and larger carrying medium less that 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is

greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.6.4 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3.2 RAINWATER HARVESTING SYSTEM

Follow the drawings and manufacturer's written instructions for installation of the rainwater harvesting system. All aboveground piping, valves, fittings, and accessories shall be as specified for domestic water supply. Underground piping from the [fiberglass reinforced plastic][modular] storage tank to the rainwater harvesting system shall be installed in accordance with Section 33 11 00 WATER DISTRIBUTION.

[3.2.1 Modular Storage Tank

Prepare the area where the tank is to be installed in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL. Install the tank in accordance with the tank manufacturer's written instructions. Provide the required types and number modules, inspection ports, inlets, outlet, and overflow connections, and accessories as recommended by the tank manufacturer. Tank shall be vented to atmospheric pressure.

][3.2.2 Fiberglass Reinforced Plastic Storage Tank

Install the tank in accordance with the tank manufacturer's written instructions. Provide the required types and number of anchors, strap sizes and number of straps, and strap locations, as recommended by the tank manufacturer. Tank shall be vented to atmospheric pressure.

]3.2.3 Submersible Feed Pump

Follow the drawings and the manufacturer's written instructions for installation of the submersible feed pump. Connect the pump controls to the rainwater control system.

3.2.4 Debris Filter

Install the debris filter in accordance with the filter manufacturer's written instructions. Install such that the top cover shall be flush with finish grade after installation is complete.

3.2.5 Initial Runoff Filter

Install the debris filter in accordance with the filter manufacturer's written instructions. Install such that the top cover shall be flush with finish grade after installation is complete.

3.2.6 Rainwater Filter, Purification, and Controls

Follow the drawings and the manufacturer's written instructions for installation of the rainwater filters, purification system and controls.

3.2.7 [Dye][and][Chlorine]Injection System

Follow the drawings and the manufacturer's written instructions for installation of the [dye][and][chlorine]injection system.

[3.2.8 Booster Pump

Follow the drawings and the manufacturer's written instructions for installation of the booster pump. Connect the pump controls to the rainwater control system.

][3.2.9 Packaged Pump System

Follow the drawings and the manufacturer's written instructions for installation of the packaged pump system. Connect the pump controls to the rainwater control system.

]3.2.10 Hydropneumatic Tank

Follow the drawings and the manufacturer's written instructions for installation of the rainwater filters, purification system and controls.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

[3.3.1 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with [ICC IPC][and the North Carolina Building Codes] at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

]3.3.2 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in[Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Isolation unit installation shall limit vibration to [_____] percent of the lowest equipment rpm.

3.5 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be provided thru the DDC for remote reading.

3.6 IDENTIFICATION SYSTEMS

3.6.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose. All hose bibbs connected to the rainwater harvesting system shall be identified with signs that say "CAUTION: RECLAIMED WATER - DO NOT DRINK". The letters on the sign shall be at least 1/2" high.

3.6.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves and switches. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow

completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as determined by the Contracting Officer. The color code shall meet base requirements.

3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.8.1 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.8.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 3000 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B 117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.8.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after

the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

3.9 TESTS, FLUSHING AND DISINFECTION

3.9.1 Rainwater Harvesting System

The following tests shall be performed on the rainwater harvesting system in accordance with [ICC IPC] and [North Carolina Building Codes][_____].

a. Rainwater Harvesting system Test.

b. Water Supply Systems Tests.

3.9.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.9.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be

repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.9.3 System Flushing

3.9.3.1 During Flushing

Before operational tests or disinfection, potable and non-potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration.

3.9.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. Automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Comply with ASHRAE 90.1 - IP for minimum efficiency requirements. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 50.12 Part 141.80(c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.9.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the rainwater harvesting system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Operation of each vacuum breaker and backflow preventer.

g. Complete operation of the rainwater harvesting system. This shall include operation under all conditions such as loss of power and low water levels in the storage tank.

3.9.5 Disinfection

After operational tests are complete, the entire domestic non-potable and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Except as herein specified, water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer.

The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 WASTE MANAGEMENT

Place materials defined as hazardous or toxic waste in designated containers. Return solvent and oil soaked rags for contaminant recovery and laundering or for proper disposal. Close and seal tightly partly used sealant and adhesive containers and store in protected, well-ventilated, fire-safe area at moderate temperature. Place used sealant and adhesive tubes and containers in areas designated for hazardous waste. Separate copper and ferrous pipe waste in accordance with the Waste Management Plan and place in designated areas for reuse.

3.11 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams.

The framed instructions shall be posted before acceptance testing of the systems.

-- End of Section --

EMCS Equipment and Points Nomenclature for Camp Lejeune

No.	Nomenclature	Description
	EQUIPMENT	
1	AHU	Air Handling Unit
2	B	Heating Water Boiler
3	B	Steam Boiler
4	C	Chiller
5	CCC	Closed Circuit Cooler
6	CCT	Closed Circuit Tower
7	COM RM	Communication Room
8	CP	Condenser Water Pump
9	CRAC	Computer Room Air Conditioner
10	CT	Cooling Tower
11	CTP	Cooling Tower Pump
12	CTRL PNL	Control Panel
13	CU	Air Cooled Condensing Unit
14	CWP	Chilled Water Supply Pump
15	DECAHP	Defense Commissary Agency HP
16	DHW	Domestic Hot Water
17	DPR	Damper
18	DTS	Dual Temperature System
19	DWP	Domestic Hot Water Pump
20	ECT	Evaporative Cooling Tower
21	EF	Exhaust Fan
22	EST	Elevated Storage Tank
23	FCU	Fan Coil Unit
24	FLTR	Filter
25	GLBT	Ground Level Booster Tank
26	HP	Heat Pump (On Ground)
27	HWP	Hot Water Pump
28	HWT	Hot Water Tank
29	HV	Heating and Ventilating Unit
30	HX	Steam to Hot Water Converter
31	LS	Lift Station
32	LP-PMP	Loop Pump
33	MAD	Mixed Air Damper
34	MAU	Make-up Air Unit
35	MZ	Multizone Unit
36	OA	Outside Air
37	OAT	Outside Air Temperature
38	PACU	Package Unit
39	PHP	Packaged Heat Pump (On Ground)
40	PX	Plate Exchanger
41	RA	Return Air
42	RAF	Return Air Fan
43	RTHP	(RTU) Packaged Rooftop Heat Pump Unit
44	RTMZ	Rooftop Multizone Unit
45	RTU	Rooftop Unit (Packaged DX)
46	RVS-VLV	Reversing Valve
47	SA	Supply Air

EMCS Equipment and Points Nomenclature for Camp Lejeune

No.	Nomenclature	Description
	EQUIPMENT	
48	STP	Secondary Treatment Plant
49	SV	Solenoid Valve/Steam Valve
50	TS	Temperature Sensor
51	TWAC	Thru-Wall Air Conditioner
52	TWHP	Thru-Wall Heat Pump
53	UH	Unit Heater
54	VAV	Variable Air Volume
55	WAC	Window Air Conditioner
56	WS	Work Station
57	WSHP	Water Source Heat Pump
58	WTP	Water Treatment Plant
59	WP	Well Pump
60	ZD	Zone Mixing Damper

EMCS Equipment and Points Nomenclature for Camp Lejeune

No.	Nomenclature	Description
	POINTS	
61	AHU-DHUM	Air Handling Unit Dehumidifier
62	AHU-OVRRD	Air Handling Unit Override
63	ALM-CMD	Alarm Command
64	ALM-HORN	Alarm Horn
65	ALM-RST	Alarm Reset
66	ALM-SIL	Alarm Silence
67	BLR-A	Boiler Alarm
68	BLR-C	Boiler Command
69	BLR-S	Boiler Start
70	BOILER-EN	Boiler Enable
71	BYPD-C	Bypass Damper Command
72	C-?	Chiller Status
73	CD-T	Cold Deck Temperature
74	CH-CMD	Chiller Command
75	CH-OVR	Chiller Override
76	CH-ALM	Chiller Alarm
77	CH-DP	Chiller Differential Pressure
78	CH-FLO-S	Chiller Flow Switch
79	CHILLER-EN	Chiller Enable
80	CHS-T	Chiller Supply Temperature
81	CHW-DP	Chilled Water Differential Pressure
82	CHW-FLOW	Chilled Water Flow
83	CHW-SYS ENABLE	Chilled Water System Enable
84	CLG-C	Cooling Command
85	CLGMAX	Cooling Maximum
86	CLG-NITE	Cooling Night Set Point
87	CLG-SP	Cooling Set Point
88	CLG-VLV	Chilled Water Valve Status
89	CLG-VLV	Chilled Water Valve Operation
90	COND1-S	Condenser 1 Status
91	COND2-S	Condenser 2 Status
92	COOL1-C	Cooling Stage 1 Command
93	COOL2-C	Cooling Stage 2 Command
94	CTFAN-C	Cooling Tower Fan Command
95	CTFAN-S	Cooling Tower Fan Status
96	CWR-T	Chilled Water Return Temperature
97	CWS-GPM	Chilled Water Supply GPM
98	CWS-T	Chilled Water Supply Temperature
99	DHW-SET	Domestic Hot Water Set Point
100	DHWS-T	Domestic Hot Water Supply Temperature
101	DHW-TANK	Domestic Hot Water Tank Temperature
102	DHW-VLV	Domestic Hot Water Steam Valve
103	ELEC-HEAT	Electric Heat
104	FLTR-DP	Filter Differential Pressure
105	FLTR-S	Air Filter Differential
106	HD-T	Hot Deck Temperature
107	HTG1-C	Heating Stage 1 Command

EMCS Equipment and Points Nomenclature for Camp Lejeune

No.	Nomenclature	Description
	POINTS	
108	HTG2-C	Heating Stage 2 Command
109	HTGMAX	Heating Maximum Set Point
110	HTG-NITE	Heating Night Set Point
111	HTG-SP	Heating Set Point
112	HTGV-CMD	Heating Command
113	HTG-VLV	Heating Valve
114	HUM-SPT	Humidity Set Point
115	HW-ENA	Hot Water Enable
116	HWP-1-C	Hot Water Pump 1 Command
117	HWP-SPT	Hot Water Pump Set Point
118	HWP-SS	Hot Water Pump Status
119	HWR-T	Hot Water Return Temperature
120	HW-SET	Hot Water Reset Set Point
121	HWS-FL	Hot Water Supply Flow
122	HWS-P	Hot Water Supply Pressure
123	HWS-SPT	Hot Water Supply Set Point
124	HWS-T	Hot Water Supply Temperature
125	HW-SYS ENABLE	Hot Water System Enable
126	HWVLV-C	Hot Water Valve Command
127	HX-VLV	Heat Exchanger Valve
128	IA-H	Indoor Humidity Sensor
129	INST-DMD	Instantaneous Demand
130	INTV-DMD	Interval Demand
131	LOOPR-T	Loop Return Temperature
132	LOOPS-T	Loop Supply Temperature
133	LPMP-1-C	Loop Pump 1 Command
134	MAD-CMD	Mixed Air Damper Command
135	MA-T	Mixed Air Temperature
136	MAX-CLG	Maximum Cooling Set Point
137	MAX-HTG	Maximum Heating Set Point
138	MIN-HTG	Minimum Heating Set Point
139	MIN-OAD	Minimum Outside Air Damper
140	OA-CFM	Outside Air Cubic Feet Per Minute
141	OAD-C	Outside Air Damper Position
142	OAD-SET	Outside Air Damper Set Point
143	OAF-C	Outside Air Fan Command
144	OAF-S	Outside Air Fan Status
145	OA-H	Outside Humidity Sensor
146	OA-RH	Outside Air Relative Humidity
147	OA-T	Outside Air Temperature
148	OCC-CLG	Occupied Cooling
149	OCC-HTG	Occupied Heating
150	OCCTIME	Occupied Time (Schedule)
151	OCCTIMER	Occupied Timer (Schedule)
152	OCLG-SP	Occupied Cooling Set Point
153	OHTG-SP]	Occupied Heating Set Point
154	OHWP-SPT	Occupied Hot Water Sump Set Point

EMCS Equipment and Points Nomenclature for Camp Lejeune

No.	Nomenclature	Description
	POINTS	
155	PH-LEV	PH Level
156	PH-SET	PH Set Point
157	PWR-FAIL	Power Fail
158	PWR-MTR	Power Meter
159	RAD-C	Return Air Damper Position
160	RAF-C	Return Air Fan Command
161	RAF-S	Return Air Fan Status
162	RA-T	Return Air Temperature
163	REV-VLV	Reversing Valve
164	RM-T	Room Temperature
165	SA-SMKD-C	Smoke Detector Command
166	SA-SMK-S	Smoke Detector Status
167	SA-SP	Supply Air Set Point
168	SA-T	Supply Air Temperature
169	SETPNT1	Set Point 1
170	SETPNT2	Set Point 2
171	SF-C	Supply Fan Command
172	SF-S	Supply Fan Status
173	SF-VFD	Supply Fan Variable Frequency Drive
174	SHDN-CMD	Shutdown Command
175	SMK-S	Duct Smoke Detector
176	STM-C	Steam Command
177	STM-S	Steam Pressure
178	STM-T	Steam Temperature
179	STM-VLV	Steam Valve Operation
180	STM-VLV	Steam Valve Status
181	SUMMER	Summer Mode
182	SUMWIN-C	Summer/Winter Command
183	TANK-L-A	Tank Level
184	TOTAL-KW	Total Kilowatt (kW)
185	TOTLFLOW	Total Flow
186	TRIPLOCK	Trip Lock Out
187	TWR-CMD	Tower Command
188	UH-ENA	Unit Heater Enable
189	UH-SPT	Unit Heater Set Point
190	UNOCC-CLG	Unoccupied Cooling
191	UNOCC-HTG	Unoccupied Heating
192	VFD-S	Variable Frequency Drive Status
193	WINDO-AC	Window Air Conditioner
194	WINTER	Winter Mode
195	WSHP-SPT	Water Source Heat Pump Set Point
196	ZNHTG-SP	Zone Heating Set Point
197	ZN-T	Space/Zone Temperature

NAVFAC
Naval Facilities Engineering Command

Interior Design Policy: Best Value Determinations Feb 2011

FAR 8.405-1 States the designer shall review at least three schedule contractors through GSA (NAVSUP BPAs). In addition to price, when determining best value, the designer may consider the factors such as special features, trade in considerations, life cycle analysis, warranty, maintenance, past performance, sustainability, comfort, delivery, training needed, technical qualifications, compatibility, and administrative costs as part of the Best Value Determination (BVD) (Enclosures 1 and 2)

If other than price is the deciding factor for selection, the designer must document the decision in a narrative paragraph as part of the BVD.

The designer must sign the BVD forms under Submitting Official

BVD REQUIREMENTS

$3,000 or less: For any procurement in the FF&E package with a value of $3,000 or less, the interior designer may utilize any BPA holder. If the BPA holders cannot supply the item, then any other manufacturer may be utilized.

Greater than $3,000 and $150,000 or less: for any procurement in the FF&E package with a value greater than $3,000 and $150,000 or less, the contractor's interior designer shall always review pricing from at least three BPA holders/manufacturers as well as UNICOR. UNICOR must always be solicited which is done by sending an email with the requirements and evaluation criteria. In addition to the review of published list prices, the contractor's interior designer must confirm the pricing with the vendor. The BVD form (Enclosure 1) must be completed and submitted for all FF&E procurements greater than $3,000 and $150,000 or less. (FAR 2.101)

Greater than $150,000: The contractor's interior designer shall solicit proposals from all BPA holders under the applicable group for FF&E procurements greater than $150,000. UNICOR must always be solicited. The contractor's interior designer shall develop performance criteria and project requirements based on a generic design for the BPA holders and UNICOR to develop a price and performance proposal. The BVD form (Enclosure 2) must be completed and submitted for all FF&E procurements greater than $150,000 (FAR 2.101)and manufacturer's quotes and a summary of all proposals must be attached.

Federal Prison Industries (UNICOR) must be considered as part of all BVDs. UNICOR contact information to obtain pricing or send solicitations is enclosed. (Enclosure 3)

This policy is in effect immediately for any projects awarded after 1 Mar 09. Any questions can be directed to Peggy Noland, CID, Supervisory Interior Designer, NAVFAC MIDLANT at 757-341-0136 or margaret.noland@navy.mil.

NAVAL FACILITIES ENGINEERING COMMAND MID-ATLANTIC
FURNITURE, FIXTURES & EQUIPMENT (FF&E) ESTIMATED COST SUMMARY

BASE:

PROJECT: **DATE:**

CODE	QTY	ITEM DESCRIPTION	MANUFACTURER	UNIT COST	TOTAL

Enclosure (1)

BEST VALUE DETERMINATION GUIDELINES
$3,000 - $150,000

(Schedule Purchases are subject to FAR 8.4, DFARS 208.4, and DFARS PGI Supplement 208.405-70) (FAR 2.101)

- FAR 8.4 required that you make a best value determination before placing Multiple Award Schedule (MAS) orders above the micro-purchase limit (currently $3,000).
- The Navy Furniture BPAs shall be the primary source for FF&E. Refer to Specification Section E20.
- For orders between $3,000 and $150,000, review pricing from at least three sources and UNICOR. (FAR 8.405-1(c)) (FAR 2.101)
- Seek additional price discounts from the contractor offering the best value. (FAR 8.405-1(d))

1. Brief Description of Item, System or Component to be Procured:

2. Did you review the required number of sources under the BPA and/or Federal Supply Schedule? YES ☐ NO ☐

3. Identify the Navy Furniture BPA or other Federal Supply Schedule utilized or indicate not applicable.

4. Was UNICOR included in the review? YES ☐ NO ☐

5. List the name(s) and contract number(s) of contractor(s) who were considered:

List three or more contractors' names, contract numbers and business size reviewed.

6. Identify the contractor recommended as the best value.

7. When you sought additional price reductions, were they received? YES ☐ NO ☐

8. Identify price with discounts for the recommended best value contractor.

9. Is installation, site preparation, design or ancillary services included in this project? YES ☐ NO ☐ If yes, be sure that the installation, site preparation, design or ancillary services are included as separate line items in each quote.

10. Are you selecting the lowest priced item? YES ☐ NO ☐ If no, indicate in addition to price, those factors listed below, considered in your decision.

- ☐ Price
- ☐ Special features required in effective program performance:
- ☐ Trade-in considerations
- ☐ Probable life of the item selected as compared with that of a comparable item: .
- ☐ Warranty considerations:
- ☐ Maintenance availability
- ☐ Past performance
- ☐ Environmental and energy efficiency considerations
- ☐ Comfort/suitability of the item:
- ☐ Delivery terms
- ☐ Your administrative costs
- ☐ Training needed or provided
- ☐ Technical qualifications
- ☐ Compatibility with existing furniture / Products / Technology (circle appropriate category)
- ☐ Other (*specify*):

11.
Best Value Determination:
A narrative justification for each box checked above for other than low price selection must be attached. Describe the evaluation factor, how the recommended best value contractor's offer met or exceeded the standard for each factor, and why the offeror represents the best value to the Government compared to the other offerors.

SUBMITTING OFFICIAL (PRIME CONTRACTOR'S INTERIOR DESIGNER)
In accordance with FAR 8.404(b), all agency specific regulations and statutes applicable to this purchase are attached. I have reviewed the findings and documentation attached and I have affirmatively determined them to be complete and accurate.

Name:_____ Title: _____ Date: _____

Telephone: _____ Email: _____

Signature:_____

Enclosure (2)

BEST VALUE DETERMINATION GUIDELINES
Greater than $150,000

(Schedule Purchases are subject to FAR 8.4, DFARS 208.4, and DFARS PGI Supplement 208.405-70) (FAR 2.101)

- FAR 8.4 required that you make a best value determination before placing Multiple Award Schedule (MAS) orders above the micro-purchase limit (currently $3,000).
- The Navy Furniture BPAs shall be the primary source for FF&E. Refer to Specification Section E20.
- For orders greater than $150,000, all BPA holders for the applicable schedule shall be given an opportunity to compete for the requirement. In addition, UNICOR shall also be solicited. (DFARS PGI 208.405-70) (FAR 2.101)
- Seek additional price discounts from the contractor offering the best value. (FAR 8.405-1(d))

1. Brief Description of Item, System or Component to be Procured:

2. Were all BPA holders and/or Federal Supply Schedule holders given the opportunity to propose on the requirement?
YES ☐ NO ☐

3. Identify the Navy Furniture BPA or other Federal Supply Schedule utilized or indicate not applicable.

4. Was UNICOR included in the review? YES ☐ NO ☐

5. Provide evidence of affording all BPA holder and/or Federal Supply Schedule holders the opportunity to compete. Also, provide evidence that UNICOR was solicited.

6. List the name(s) and contract number(s) of contractor(s) who responded to the request for proposal for this requirement:
List contractors' names, contract numbers and business size for those who responded.

7. Provide copies of all quotes received and reviewed.

8. Identify the contractor recommended as the best value.

9. When you sought additional price reductions, were they received? YES ☐ NO ☐

10. Identify price with discounts for the recommended best value contractor.

11. Is installation, site preparation, design or ancillary services included in this project? YES ☐ NO ☐
If yes, be sure that the installation, site preparation, design or ancillary services are included as separate line items in each quote.

12. Are you selecting the lowest priced item? YES ☐ NO ☐
If no, indicate in addition to price, those factors listed below, considered in your decision.

- ☐ Price
- ☐ Special features required in effective program performance:
- ☐ Trade-in considerations
- ☐ Probable life of the item selected as compared with that of a comparable item: .
- ☐ Warranty considerations:
- ☐ Maintenance availability
- ☐ Past performance
- ☐ Environmental and energy efficiency considerations
- ☐ Comfort/suitability of the item:
- ☐ Delivery terms
- ☐ Your administrative costs
- ☐ Training needed or provided
- ☐ Technical qualifications
- ☐ Compatibility with existing furniture / Products / Technology (circle appropriate category)
- ☐ Other (*specify*):

13.
Best Value Determination:
A narrative justification for each box checked above for other than low price selection must be attached. Describe the evaluation factor, how the recommended best value contractor's offer met or exceeded the standard for each factor, and why the offeror represents the best value to the Government compared to the other offerors.

SUBMITTING OFFICIAL (PRIME CONTRACTOR'S INTERIOR DESIGNER)
In accordance with FAR 8.404(b), all agency specific regulations and statutes applicable to this purchase are attached. I have reviewed the findings and documentation attached and I have affirmatively determined them to be complete and accurate.

Name:_____ Title: _____ Date: _____

Telephone: _____ Email: _____

Signature:_____

FURNITURE PROCUREMENT DATA SHEET

_____ DIVISION **SHEET:**

NAVAL FACILITIES ENGINEERING COMMAND **DATE:**

PROJECT/LOCATION:			**PROJECT #:**
ITEM:			**ITEM CODE:**
FSC GRP:	**PART:** **SECTION:**	**EXP: DATE:** **MOL:**	**GSA #/OPEN MARKET :** **FED. STOCK #:**

MANUFACTURER: **ORDERING ADDRESS:**

CONTRACTOR: **SHIP TO ADDRESS** (if applicable):

LOCAL REP: **PHONE NUMBER:**

ANY VARIANCE OR MODIFICATION OF THIS SPECIFICATION WILL BE COORDINATED THROUGH _____ DIVISION, NAVAL FACILITIES ENGINEERING COMMAND.

CONTACT:

_____, INTERIOR DESIGNER, _____NAVFACENGCOM, ___(Phone)_____

DESCRIPTION:	QTY:	UNIT COST:	TOTAL COST:
LOCATION OF ITEMS			
NOTES/SPECIAL INSTRUCTIONS			
TOTAL:			

FOB/REMARKS:

file name:

FURNITURE PROCUREMENT DATA SHEET (continued)
_____ DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

MANUFACTURER:

ITEM NO.:

photo of item here

FINISH:

representative finish here

file name:

NAVAL FACILITIES ENGINEERING COMMAND MID-ATLANTIC SHEET:
DATE:

PROJECT: **ITEM CODE:**
BASE/CITY/STATE:
ITEM:

BPA CONTRACT #: **EXPIRATION DATE:**
GSA CONTRACT #:
MANUFACTURER: **ORDERING ADDRESS:**

LOCAL REP CONTACT INFO:

ANY VARIANCE OR MODIFICATION OF THIS SPECIFICATION WILL BE COORDINATED THROUGH NAVFAC MID-ATLANTIC

NAVFAC ID CONTACT:
PROJECT ID CONTACT:

DESCRIPTION:	QTY:	UNIT COST:	TOTAL COST:
TOTAL:			

ROOM LOCATIONS: **ENVIRONMENTAL CERTIFICATIONS:**
QTY **ROOM NUMBER**

REMARKS:

ITEM PHOTO/FINISH SAMPLES

PERMITS RECORD OF DECISION (PROD)

PERMIT REQUIRED (Check Box)	PROJECT TITLE:	WORK ORDER NUMBER:
	LOCATION:	
	GOVERNMENT PROJECT MANAGER:	

**Use referenced notes where additional space required.

Air Quality	**PERMIT: Construction**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Air Quality	**PERMIT: Operating**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Air Quality	**PERMIT: Asbestos Demolition & Removal**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Air Quality	**PERMIT: Other**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD*)*

PERMIT REQUIRED (Check Box)	PROJECT TITLE:		WORK ORDER NUMBER:
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Water Pollution	**PERMIT: Wastewater Collection System**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Water Pollution	**PERMIT: Wastewater Pump Station**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency		
	Special Provisions and Requirements:		
Water Pollution	**PERMIT: Wastewater Treatment Plant**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Water Pollution	**PERMIT: Pretreatment, i.e. Oil/Water Separator**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD)

PERMIT REQUIRED (Check Box)	PROJECT TITLE:		WORK ORDER NUMBER:
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Water Pollution	**PERMIT: Septic System**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Water Pollution	**PERMIT: Erosion & Sediment Control**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Water Pollution	**PERMIT: Stormwater Management**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Water Pollution	**PERMIT: Other**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD)

PERMIT REQUIRED (Check Box)	PROJECT TITLE:		WORK ORDER NUMBER:
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Discharge Permit	**PERMIT: New or Increased Capacity NPDES**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Discharge Permit	**PERMIT: General NPDES (≥1 Acre Land Disturbance)**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Discharge Permit	**PERMIT: Other**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Drinking Water	**PERMIT: Water Distribution System**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD*)*

PERMIT REQUIRED (Check Box)	PROJECT TITLE:		WORK ORDER NUMBER:
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Drinking Water	**PERMIT: Water Treatment Plant**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Drinking Water	**PERMIT: Well Construction**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Drinking Water	**PERMIT: Underground Injection**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Drinking Water	**PERMIT: Other**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD*)*

PERMIT REQUIRED (Check Box)	PROJECT TITLE:	WORK ORDER NUMBER:
	LOCATION:	
	GOVERNMENT PROJECT MANAGER:	
Fuel Tanks	**PERMIT: Underground Storage Tank Construction** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	
Fuel Tanks	**PERMIT: Underground Storage Tank Operating**	
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	
Fuel Tanks	**PERMIT: Other** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions, and Requirements:	
Solid and Hazardous Waste	**PERMIT: Hazardous Waste Treatment, Storage, Disposal, Handling** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	

PERMITS RECORD OF DECISION (PROD*)*

PERMIT REQUIRED (Check Box)	PROJECT TITLE:	WORK ORDER NUMBER:
	LOCATION:	
	GOVERNMENT PROJECT MANAGER:	
Solid and Hazardous Waste	**PERMIT: Landfill** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	
Solid and Hazardous Waste	**PERMIT: Used Oil Collection Center, Aggregation Point, Transporter & Transfer Facility** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	
Solid and Hazardous Waste	**PERMIT: Other** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	
Coastal Management Permit	**PERMIT: Coastal Consistency Determination Authorization** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	

PERMITS RECORD OF DECISION (PROD)

PERMIT REQUIRED (Check Box)	PROJECT TITLE:		WORK ORDER NUMBER:
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Coastal Management Permit	**PERMIT: Coastal Barrier**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Coastal Management Permit	**PERMIT: Floodplain Management**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Coastal Management Permit	**PERMIT: Other**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Work in Navigable Waters**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD)

PERMIT REQUIRED (Check Box)	PROJECT TITLE:		WORK ORDER NUMBER:
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Other Permits	**PERMIT: Dredging**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Clearing**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Essential Fish Habitat Assessment Consultation**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Marine Mammal Protection Act**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD*)*

PERMIT REQUIRED (Check Box)	PROJECT TITLE:		WORK ORDER NUMBER:
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Other Permits	**PERMIT: Take Permits**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Work in Wetlands**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Digging Permit**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Traffic**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD*)*

PERMIT REQUIRED (Check Box)			
	PROJECT TITLE:		**WORK ORDER NUMBER:**
	LOCATION:		
	GOVERNMENT PROJECT MANAGER:		
Other Permits	**PERMIT: Airport Hazard/Airfield Safety Clearances**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Railroad Crossing**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Historic Preservation**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		
Other Permits	**PERMIT: Noise Abatement**	Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**		
	Issuing Agency:		
	Special Provisions and Requirements:**		

PERMITS RECORD OF DECISION (PROD*)*

PERMIT REQUIRED (Check Box)	PROJECT TITLE:	WORK ORDER NUMBER:
	LOCATION:	
	GOVERNMENT PROJECT MANAGER:	
Other Permits	**PERMIT: Endangered/Species/Critical Habitat** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	
Other Permits	**PERMIT: Other** Date Obtained:	Date Closed:
☐	Basis of Decision (Yes/No):**	
	Issuing Agency:	
	Special Provisions and Requirements:**	

_____ _____

Prepared by: *Date*

May 2002

Seismic Design for Mechanical Systems

The forces exerted by an earthquake on a structure, or, more specifically, the mechanical systems within a building can be in any direction. However, since every building, and mechanical system support, is designed to take care of the vertical, or gravity, loads, the main emphasis for seismic design is in the control of horizontal forces exerted during a seismic event. The vertical load component for equipment is its operating weight. For ducts and pipes, the vertical load component includes the weight of the duct or pipe and the contained fluid.

The design of structural seismic restraints for mechanical systems assumes the building is designed to respond safely during earthquake events. The restraints' primary function is to insure the mechanical systems do not break away, but move with the building during an earthquake.

Because the direction of forces during an earthquake are unpredictable, and can be in any direction, it is important to provide restraint in the X, Y, and Z directions; vertically, laterally (transverse), and longitudinally. Together, transverse and longitudinal bracing with vertical (gravity) supports will resist seismic loads in all directions. The bracing that will be referenced in this guidance will provide for the additional members required to resist the horizontal forces during an earthquake.

Code references in this guidance are based on the policy established by Planning and Design Policy Statement 95-02, which adopted the International Mechanical Code (IMC) as NAVFAC's sole mechanical code. The IMC is published by three entities in the United States including: the Building Officials and Code Administrators International, Inc. (BOCA), the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International, Inc. (SBCCI). Use of these U.S. Codes for projects outside the continental U.S. is contingent upon the engineer to determine it to be more strict than what the local requires; standard procedure requires the engineer to apply the strictest of U.S. and local codes in foreign countries.

• Seismic Bracing for Pipe and Duct

All building codes, including BOCA, require most structures to be designed for a horizontal seismic force. The formulas to determine the horizontal seismic force are in the form of:

$$Fp = Cs * Wp$$

where:

	Fp	=	seismic force
	Cs	=	seismic coefficient
	Wp	=	weight of the ducts or pipes

Horizontal seismic forces may also is expressed as a percentage of the weight of the elements being braced. It is this percentage that correlates to a design nation utilized by SMACNA called the "Seismic Hazard Level" (SHL) that will be addressed later and is fully explained in "Appendix A" of the SMACNA Restraint Manual, Second Edition. The codes have formulas for calculating the percentage horizontal seismic force based on the seismic zone, the importance factor, and the type construction.

The percent horizontal seismic factor is expressed as:

$$\%F = [Fp \div Wp] * 100$$

and: $Cs = [Fp \div Wp]$

$= Cs * 100$

More specifically, the formula in the IMC and used in the Building Officials and Code Administrators International, Inc. (BOCA), National Building Code, 1996, Chapter 16 to determine the seismic force is:

$$Fp = Av * Cc * P * Ac * Wc$$

where:
- Av = Figure 1610.1.3(1)
- Cc = Figure 1610.6.4(1)
- P = Figure 1610.6.4(1); requires determination of "SHEG"
- SHEG = Seismic Hazard Exposure Group, Table 1610.1.5
- Ac = Figure 1610.6.4(2)

Conveniently, the percent horizontal seismic factor is expressed as:

$\%F = [Fp \div Wc] * 100$

$= [Av * Cc * P * Ac] * 100$

The "Seismic Hazard Level", SHL, designation was developed specifically for the SMACNA Restraint Manual, Second Edition. It is a designation of "A", "B", or "C" that combines s everal building codes, seismic zones, and other factors into a single system for determining appropriate restraints. SHL's are established by prescribed limits of resistive force as a percentage of weight of the ducts and pipes and correlate to the percent horizontal seismic factors, (%F), determined by building code formulas. The prescribed limits for the SHL's are with "A" being the most stringent, and "C" the least:

- Most stringent; covers buildings most vulnerable due to the strength of seismic events . The bracing for SHL "A" is designed to resist 48% of the weight of the ducts or pipes. If %F is = 48, then use SHL "A". If %F is > 48, the SMACNA Restraint Manual, Second Edition, cannot be used.

- The bracing for SHL "B" is designed to resist 30% of th e weight of the ducts or pipes. If %F is = 30, then use SHL "B".

- Least stringent; covers buildings least vulnerable due to the strength of seismic events. The bracing for SHL "C" is designed to resist 15% of the weight of the ducts or pipes. If %F is = 15, then use SHL "C".

Determination of the SHL for a specific project is fundamental, and indeed the first step in the use of the SMACNA Restraint Manual, Second Edition . The bracing detailed in the SMACNA Restraint Manual, Second Edition provides for the additional members needed to resist horizontal forces in pipe and duct systems. It does not cover seismic restraints for equipment. All in-line equipment must be braced independently of all the ducts or pipes and in conformance with all applicable buildi ng codes. Additionally, SMACNA does not consider forces due to thermal expansion; seismic bracing referenced here is not intended to handle forces imposed by thermal expansion.

Steps in the Use of SMACNA Sizing Tables:

Step 1. Determine the Seismic Hazard Level (SHL). *The determination of the SHL requires familiarity with the earthquake design portion of the building codes, and **shall not** be left up to a contactor to establish; the design engineer **must** specify the SHL in the contract documents.*

The SHL for each Seismic Hazard Exposure Group (see Table 1610.1.5, National Building Code, 1996, Chapter 16) within a specific geographic location in the LANTNAVFACENGCOM jurisdiction are presented in Table 1, entitled "SHL Factors".

Table 1

Seismic Hazard Level (SHL) Factors

Geographic Location	Seismic Hazard Exposure Group (SHEG) (Note 1)	Factors					Seismic Hazard Level (SHL)	
		Av	Cc		P	Ac	Duct & Non-Hazardous Pipe	Gas & Hazardous Pipe
			Duct & Non-Haz Pipe	Gas & Haz Pipe Boilers (Note 2)				
Tidewater Virginia	I	0.05	0.67	2.0	0.5	1.0	C	B
	II	0.05	0.67	2.0	1.0	1.0	C	B
	III	0.05	0.67	2.0	1.5	1.0	C	B
MCAS Cherry Point	I	0.10	0.67	2.0	0.5	1.0	C	B
MCB Camp Lejeune	II	0.10	0.67	2.0	1.0	1.0	C	B
MCAS New River	III	0.10	0.67	2.0	1.5	1.0	C	B
Sugar Grove, WVA	I	0.05	0.67	2.0	0.5	1.0	C	B
	II	0.05	0.67	2.0	1.0	1.0	C	B
	III	0.05	0.67	2.0	1.5	1.0	C	B
Puerto Rico	I	0.20	0.67	2.0	0.5	1.0	C	(Note 3)
	II	0.20	0.67	2.0	1.0	1.0	C	(Note 3)
	III	0.20	0.67	2.0	1.5	1.0	B	(Note 3)
Naples, Italy	I	0.15	0.67	2.0	0.5	1.0	C	A
	II	0.15	0.67	2.0	1.0	1.0	C	A
	III	0.15	0.67	2.0	1.5	1.0	B	A
Sigonella, Italy	I	0.40	0.67	2.0	0.5	1.0	C	(Note 3)
	II	0.40	0.67	2.0	1.0	1.0	B	(Note 3)
	III	0.40	0.67	2.0	1.5	1.0	A	(Note 3)
Aviano AFB, Italy	I	0.15	0.67	2.0	0.5	1.0	C	A
	II	0.15	0.67	2.0	1.0	1.0	C	A
	III	0.15	0.67	2.0	1.5	1.0	B	A
Iceland	I	0.40	0.67	2.0	0.5	1.0	C	(Note 3)
	II	0.40	0.67	2.0	1.0	1.0	B	(Note 3)
	III	0.40	0.67	2.0	1.5	1.0	A	(Note 3)

Notes:

(1) See Table 1610.1.5, the BOCA National Building Code f or Seismic Hazard Exposure Group classifications

(2) Includes boilers, furnaces, incinerators, water heaters, and other equipment utilizing combustible energy sources

(3) The horizontal seismic factor percentage exceeds 50%; SMACNA Restraint Manual, Second Edition, cannot be used.

Step 2. Check the structural system to determine the type structure from which ducts and pipes are supported. If SHL "A" has been specified, determine the connection level.

- When working in SHL "A", one of two con nection levels to the supporting structure must be selected.
    - Connection Level "2" is the most strict condition.
        - Must be used in the State of California within the jurisdiction of OSHPD (California hospitals) and the Office of the State Architect (OSA)(California schools).
        - Conservatively, use this connection level for any area of structural concrete.
    - Use of Connection Level "1" may be used if it is substantiated. May be used anywhere except when connecting into concrete within the jurisdiction of OSHOD (California hospitals) and the Office of the State Architect (OSA)(California schools).

Step 3. Find the detail in the SMACNA Restraint Manual, Second Edition (Chapter 4), which corresponds to the type duct or pipe restraint required. Notes in the detail will refer to the table where member sizes and connections can be found.

Step 4. Determine which chapter of the SMACNA Restraint Manual, Second Edition provides the table for the SHL for your specific project.

- For SHL "A", use Chapter 5.
- For SHL "B", use Chapter 6.
- For SHL "C", use Chapter 7.

Step 5. In the chapter determined by Step 4, find the table referred to in the detail from Chapter 4 of the SMACNA Restraint Manual, Second Edition by Step 3.

Step 6. In the first column, find the duct or pipe size. If the exact size is not liste d, use the next larger size. Ducts are assumed to be of SMACNA standard construction and pipes are assumed to be Schedule 40 water pipes. If pipes are insulated or of heavy construction, the weight of the duct or pipe must be determined and the "weight column" in the tables must be used to select the proper braces.

Step 7. Once the appropriate row in the table has been found, move to the right to read the size requirements for the hangers, braces and bolts.

Step 8. In the same row, under the column "Connection Type to Structural Member", find the connection type designated by a capital letter (A through H). For SHL "A", use the connection level determined in Step 2 to find the connection type.

Step 9. Find the connection type in the first column in Table 8 -1 in Chapter 8 of the SMACNA Restraint Manual, Second Edition. Move to the right in the same row to find sizes for the expansion anchors, bolts, spreader sizes, and angle connectors for connecting to the supporting structure.

Step 10. Find a detail in Chapter 8 of the SMACNA Restraint Manual, Second Edition that corresponds to your connection type and to your type of supporting structural system. Install transverse and longitudinal seismic braces at the intervals specified in the general requirements for ducts in Chapter 3 or the t ables for pipes in Chapters 5, 6, or 7 of the SMACNA Restraint Manual.

• Seismic Bracing for HVAC Equipment

As with the design of seismic bracing of pipe and duct, the initial step to design restraints for HVAC equipment is to consult the appropriate code. Here, the same code references apply, specifically, Chapter 16 of the Building Officials and Code Administrators International, Inc. (BOCA **)**, National Building Code, 1996.

The BOCA Code provides a seismic force formula to determine the horizontal seismic static force acting at the center of gravity of HVAC equipment. That formula takes the form of:

$$Fp = Av * Cc * P * Ac * Wc$$

where:	Av	=	Figure 1610.1.3(1)
	Cc	=	Figure 1610.6.4(1)
	P	=	Figure 1610.6.4(1); requires determination of "SHEG"
	SHEG	=	Seismic Hazard Exposure Group, Table 1610.1.5
	Ac	=	Figure 1610.6.4(2)

Once the seismic force (Fp) is determine d, the seismic loads at the connection between the equipment and the building must be resolved. Static load calculations will be required and examples showing how to compute the loads may be found in the ASHRAE Handbook, HVAC Applications and the ASHRAE, A Practical Guide to Seismic Restraint .

Seismic restraint of HVAC equipment will depend on how the equipment is isolated and whether it is supported on the floor, or from the wall, or overhead.

• Seismic Design Requirements

- **General Requirements:**

  Use either cable or solid bracing for all situations. Do not mix bracing types.

  All runs must have a minimum of two transverse braces and on longitudinal brace. A run is defined as a length of duct or pipe without any change in direction except as allowed by offsets (see Chapter 4 of the SMACNA Restraint Manual, Second Edition).

- **Duct Bracing:**

  Brace all ducts with a cross-sectional area of 0.56 sm (6 ft²), or greater; Rectangular ductwork less than 0.56 sm (6 ft²) in cross -section does not require seismic restraint.

  Round duct less than 710 mm (28”) diameter does not require seismic restraint.

  Brace flat oval ducts in the same manner as rectangular ducts.

  No bracing is required if the duct is suspended by hangers 305 mm (12”), or less, in length, as measured from the top of the duct to the bottom of the support where the hanger is attached.

  Hangers must be attached to the duct within 50 mm (2”) of the top of the duct with a minimum of two M5 x 0.8 (#10) sheet metal screws.

  Transverse bracing must occur at intervals specified in tables in Chapters 5, 6, and 7, of the SMACNA Restraint Manual, Second Edition or at both ends if the duct run is less than the specified interval. Transverse bracing will be installed at each duct turn and at each end of the duct run, with a minimum of one brace at each end.

  Longitudinal bracing must occur at the interval specified in tables in Chapters 5, 6, and 7 of the SMACNA Restraint Manual, Second Edition , with at least one brace per duct run. Transverse bracing for one du ct section may also act a s a longitudinal brace for a duct section at 90º turns if the bracing is installed within two times the duct width of the intersection of both ducts and the bracing is sized for the larger duct (see Figure 4-1, Chapter 4 of the SMACNA Restraint Manual, Second Edition).

  A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selec ted.

  Example: To brace a 760 mm x 760 mm (30”x30”) duct adjacent to a 1370 mm x 710 mm (54”x28”) duct, select bracing for an 2134 mm x 1067mm (84”x42”) duct. The horizontal dimension of the 2134 mm x 1067 mm (84”x42”) duct is equal to that of the combined ducts and its weight is greater than their combined weights.

  Walls, including gypsum board non-load bearing partitions that have ducts running through them, may replace a typical transverse brace. Provide solid blocking around duct penetrations at all stud wall construction.

  Unbraced ducts must be installed with a 150 mm (6”) minimum clearance to vertical ceiling hanger wires.

- **Pipe Bracing:**

  Brace all fuel oil, natural gas, medical gas, and compressed air piping in accordance with local codes.

  Brace all piping located in boiler, mechanical equipment, and refrigeration mechanical rooms that is 32 mm (1¼”) nominal diameter and greater.

  Brace all pipes 65 mm (2½”) nominal diameter and greater.

Piping suspended by individual hangers 305 mm (12”), or less, in length (as measured from the top of the pipe to the bottom of the support where the hanger is attached) need not be braced. For pipes on a trapeze, the 305 mm (12”) exception is measured from the upper face of the horizontal structure member (or the bottom of the pipe).

Transverse bracing must be at 12-meter (40 ft) minimum intervals, except where a lesser spacing is indicated in the tables for pipe bracing.

Longitudinal bracing must be at 24-meter (80 ft) minimum intervals, except where a lesser spacing is indicated in the tables.

For gas piping, the bracing details, schedules, and notes may be used, except that transverse and longitudinal bracing will be at one-half the spacing shown in the tables in Chapter 5 of the SMACNA Restraint Manual, Second Edition. Provide seismic automatic shut-off valves where required by NAVFAC Specifications 15195N, Natural Gas Piping, and 02556a, Gas Distribution Systems.

Transverse bracing for one pipe section may also act as the longitudinal brace for a pipe section of the same size at a 90º turn if the bracing is installed within 610 mm (24”) of the elbow as long as the brace is sized as a longitudinal brace (see Figure 4-1 of the SMACNA Restraint Manual, Second Edition).

Provide joints capable of accommodating seismic movements where pipes pass through building seismic or expansion joints or where rigidly supported pipes connect to equipment with vibration isolators. The joints must allow movement in all directions.

Branch lines may not be used to brace main lines.

Cast iron pipe of all types, glass pipe, and any other pipe joined with a shield and clamp assembly, where the top of the pipe is 610 mm (24”), or more, from the supported structure, must be braced on each side of the change in direction of 90º or more. Riser joints must be braced or stabilized between floors.

Vertical risers not specifically engineered must be laterally supported with a riser clamp at each floor. For buildings greater than six floors, all risers must be engineered individually. For risers in hubless piping systems where the riser joints are unsupported between floors, see Figure 9-10 of the SMACNA Restraint Manual, Second Edition for brace.

- **HVAC Equipment Bracing:**

  Mechanical equipment less than 181 kg (400 lbs) does not require seismic restraint.

  - **Seismic Restraint of Equipment without Vibration Isolators:**

    Seismic restraint of floor-mounted equipment without vibration isolation is most straightforward and easiest to address. Such equipment, like tube heat exchangers and storage tanks, without moving parts are simply bolted to the floor. Equipment, such as exhaust fans and small pumps, mounted in non-vibration sensitive locations may also be simply bolted to the floor or slab. The calculated seismic force determines the specific means of anchorage. The engineered anchorage must address the type and size of the anchor bolts, with particular attention given to the clearance around the bolt. Excessive clearances

between bolts and equipment may lead to anchor failure due to shear during earthquakes. Neoprene grommets or epoxy fillers should be used fill the clearances. Anchorage to steel, wood and concrete requires additional considerations:

- Anchorage to steel: Consult the "American Institute of Steel Construction Manual" for the actual strength of the anchor bolts.

- Anchorage to wood: The strength of an anchor to wood depends on the type and grade of wood as well as the embedment. Generally, a 15 mm (1/2") to 20 mm (3/4") diameter lag bolt with a depth of 50 mm (2") to 75 mm (3") provides adequate anchorage.

- Anchorage to concrete: Set-in-concrete anchor bolts are not practical. Use post drill anchors where practical. ASHRAE, A Practical Guide to Seismic Restraint provides specific information on their use. Anchorage for large equipment (>11 metric tons) in high seismic zones may make the use of numerous post drill anchors impractical. Other solutions may include the connection of embedment plates to structural elements of a reinforced slab.

Bracing of non-vibration isolated, suspended equipment such as small in-line pumps, fan coils, mixing boxes, water source heat pumps and the like, involves nothing more than to keep the equipment from swaying into adjacent equipment, pipes, ducts or structure. Anti-sway bracing may be accomplished by use of slack cables or steel struts. ASHRAE recommends use of prestretched aircraft quality cable. Additional information can be found in ASHRAE, A Practical Guide to Seismic Restraint.

- **Seismic Restraint of Equipment with Vibration Isolators:**

Seismic restraint for equipment mounted on vibration isolators is more complex since the isolators tend to amplify seismic forces. Amplification occurs because vibration isolators usually have the same natural resonant frequency as an earthquake energy peak. To quell the amplified movement of equipment on vibration isolators, snubbing devices or sway braces are employed. Considerations on the use of snubbers and sway braces include:

- Clearances around snubbers should be about 6 mm (1/4"). Larger gaps will permit high inertia forces that will increase load on equipment. Smaller gaps could hinder the effectiveness of vibration isolators.

- Chillers and boilers, etc. can be directly mounted on seismic snubbers with built-in vibration isolators.

- Floor mounted, lightweight equipment not having adequate stiffness may require supplemental structural bases to prevent buckling at snubbers. Most airside equipment falls in this category.

- Floor mounted pumps may require concrete bases to control distortion to bearings, couplings and seals when point mounted on vibration isolators.

- For adequate stiffness, concrete base thickness should be $1/12^{th}$ of the maximum span between isolators, but no less than 150 mm (6"). The depth of structural members in steel bases should be $1/10^{th}$ of the maximum span between isolators, but no less than 100 mm (4").

- Many manufacturers employ internal isolators in their equipment. Because the unit casings are commonly lightweight sheet metal, they are not structurally adequate to incorporate snubbing devices, or there is not adequate clearance within the case to prevent contact between components. ASHRAE recommends cautious use of internal seismic mountings and snubbers and only with written guarantees from the equipment manufacturer or from an independent certified test.

- Use snubber devices on wall-mounted equipment such as propeller fans, some air handling units and exhaust fans, if equipped with vibration isolators.

- Sway bracing consisting of slack cable is required for suspended HVAC equipment to prevent the pendulum effect; a rigid sway brace of channel or angle steel would cause transfer of vibration to the structure.

  Sway bracing cable may be attached to the top of bottom of the unit and at least for cables per unit will be required for proper seismic restraint.

  When employing the sway bracing cable system, particular attention must be paid to the cable connection to the building structure. Consult ASHRAE, A Practical Guide to Seismic Restraint for specific guidance.

• Drawing Requirements

Seismic restraint detailing for mechanical and plumbing systems, complete and appropriate for the project location and seismic hazard exposure group, shall be provided on the contract drawings. It shall be incumbent upon the A& E to determine the Seismic Hazard Level (SHL) factor and to clearly indicate the determination on the mechanical and plumbing contract drawings.

2009 Professional Engineer's Guide to the ENERGY STAR ® Label for Commercial Buildings

US Environmental Protection Agency
Office of Air and Radiation 2009

Introduction

Since January 1999, the U. S. Environmental Protection Agency (US EPA) has provided the public with the means to quickly and easily assess, *or benchmark*, the energy performance of commercial buildings relative to similar buildings in the United States. Accounting for the most significant drivers of energy intensity such as weather and operating characteristics, a building whose performance is among the nation's top 25 percent (equal to an energy performance rating of 75 or greater on a 1 to 100 scale) and prove to maintain a healthy indoor environment can qualify as an ENERGY STAR building.

EPA's Portfolio Manager is an on-line, interactive, software tool that makes benchmarking energy performance simple and accessible. Portfolio Manager is based on statistical models developed by the US EPA that correlate energy data to operational characteristics for each building type to identify the key drivers of energy use[1]. Based on physical and operating characteristics, such as size, number of workers, operating hours per week, number of PCs, etc., the rating system evaluates and communicates the energy performance of a building relative to other buildings with similar characteristics in the United States.

After the building's energy performance is assessed, users can apply for the ENERGY STAR label by completing an Application Letter and a Statement of Energy Performance (See **Appendix C**). The Statement of Energy Performance is a stand-alone document designed to communicate not only a building's energy performance, but also its physical characteristics, operating characteristics, and whether it meets industry standards for the following indoor environment conditions: thermal comfort, adequate ventilation and illumination. Once all information is validated by a professional engineer (PE), the Statement of Energy Performance becomes an official document that can be used to apply for the ENERGY STAR label. The role of the PE is essential to certify true superior energy performance and to assure that indoor environmental quality was not compromised in pursuit of energy conservation.

Professional Engineers provide unbiased engineering services and are legally bound to uphold standards of ethics. Because of this high level of professionalism, experience, and expertise, a PE is required to validate each Statement of Energy Performance that is used to apply for the ENERGY STAR label. Namely, the PE's key role is to verify that all data supplied to EPA is correct and the building is fully functional in accordance with industry standards. The PE is not obligated to count up each individual building attribute, but should be able to use his/her professional judgment to assess whether indoor environmental quality standards have been met in the building (and have not been compromised in pursuit of energy conservation). Additionally, the PE must verify that all information provided in the Statement of Energy Performance and on the Data Checklist is accurate. Services performed by PEs in connection with the ENERGY STAR label shall in no way be construed to diminish or otherwise modify the responsibilities or liability of the original designer or operator of the building.

Validating a Statement of Energy Performance and Data Checklist requires the PE to review two categories of user-provided information. These verifications by the PE are one step in the rigorous review process of a label application. For more on the on the labeling application process, which is at the responsibility of the building owner/manager, see **Appendix G**.

I. The PE must verify that the data entered about the building are accurate. This includes verifying the building's physical characteristics, operating characteristics, and energy consumption. All building characteristics are provided in entirety on the data checklist and must be verified through a site visit by the PE.
II. During the site visit the PE must also verify that the building complies with current industry standards for indoor environment quality including thermal comfort, illumination, outside air ventilation, and control of indoor air pollutants (See modules 4, 5 & 6). These standards are meant to provide general guidance for a comfortable and healthy work environment. Given nuances in the feasibility of some buildings to renovate and conform to these strict standards, it us up to the PE's

[1] EPA conducts statistical analysis on the data gathered by the Department of Energy's Energy Information Administration during its quadrennial Commercial Building Energy Consumption Survey (CBECS). For more information on how the rating is calculated and supporting documents on the statistical models, please visit our supporting documents page http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager_docs

professional judgment as to whether the building as a whole provides a suitable work environment for those subject to the respective working conditions.

This document, *The Professional Engineer's Guide to the ENERGY STAR Label for Buildings*, is intended to assist the PE community in understanding the requirements of the Statement of Energy Performance, the Data Checklist, and the expectations and limitations of the PE's role in the ENERGY STAR labeling process. Each module covers a single topic and contains a purpose, background, expectations, hints and tips, and questions and answers. Where needed, industry standards are referenced and detailed tables are provided to illustrate the relevant standard requirements. However, this document is not intended to take the place of the referenced standards; the PE should refer to the standards for more complete information about standard requirements[2].

EPA is committed to continually improving the content of this document, and welcomes all comments that may help us do so. All applicable contact information is provided in **Appendix A**.

EPA thanks you for choosing to take part in the ENERGY STAR labeling process. We hope you find this experience professionally rewarding and are able to forge new or expand existing business relationships. In so doing, you can be assured that you are helping to mitigate society's impact on the environment and climate change.

[2] For additional guidance on indoor air quality outside the scope of this document please visit EPA's Indoor Environments Division (IED) website (http://www.epa.gov/iaq/).

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Module 1: Physical Characteristics

1.1 Objective:

All recorded physical characteristics displayed on a building's Statement of Energy Performance must be verified when applying for the ENERGY STAR label.

1.2 Background and Expectations of PE:

To assess the energy performance of a building, all physical characteristics must be accurately portrayed by the user. The PE is expected to verify the accuracy of the building's recorded physical characteristics which include building floor area in square feet (ft^2), building name, location, etc. A checklist of these items to be verified is provided at the end this module. These items must be verified to be true and accurately displayed on the Statement of Energy Performance.

1.3 Building Designation Requirement:

The information needed to complete a Statement of Energy Performance and/or to apply for the ENERGY STAR label varies by building type and is given below. Currently there are eleven eligible building space types. Definitions of all building and space types are provided in **Appendix D**. More than 50% of your building's gross floor area (excluding parking lots and garages) must be defined by one of the following space types:

- Bank / Financial Institution
- Courthouse
- Dormitory
- Hospital (acute and children's)
- Hotel
- K-12 School
- Medical Office
- Office
- Retail Store
- Supermarket / Grocery Store
- Warehouse (refrigerated and non-refrigerated)

1.4 Physical Characteristics Requirements:

All buildings must meet the following requirements pertaining to gross square foot, location, parking structures and pools.

- The gross floor area of the building (excluding garage and parking lot) must be at least 5,000 square feet, with two exceptions:
    a. Bank / Financial Institutions must be at least 1,000 square feet
    b. Hospitals must be at least 20,000 square feet
- The building must be located within the United States of America or its territories. Buildings owned by the United States government that are located in foreign lands are also eligible. A 5-digit ZIP code must be recorded for buildings located in the USA or its territories. For buildings owned by the United States government that are located in foreign lands, the location most closely related to the building in terms of climate must be indicated. Typically, this is the location

nearest that of the building. Choices of location are by major city that has an international airport. In some cases there may be only one location for an entire country.

- The presence of a swimming pool on the same utility meter, its size and if the pool is located inside or outside of the facility must be recorded.
- Total square foot of parking structures, data centers, and any space marked as "other" must be verified and are subject to the following restrictions.
    a. The combined floor area of all the Parking Garages or Parking Lots cannot exceed the total gross floor area of the building (where the gross floor area of the building excludes the parking garage/parking lot). Additionally, The presence of an attached parking structure on the same utility meter(s) must be recorded.
    b. The combined floor area of all Computer Data Centers cannot exceed 10% of the total gross floor area of the building (where the gross floor area of the building excludes the parking garage/parking lot).
    c. The combined floor area of any space classified as "Other" cannot exceed 10% of the total gross floor area of the building (where gross floor area of the building excludes the parking garage/parking lot).
    d. The combined floor area of all Multifamily Housing space cannot exceed 10% of the total gross floor area of the building (where gross floor area of the building excludes the parking garage/parking lot).
- If the peer group of comparison is Hospital (i.e. if Hospital accounts for more than 50% of your space), no other unique spaces should be entered except for parking garages, parking lots, and raised floor computer data centers.
- The building being evaluated must be a single structure and not a campus or plaza (except if the building is identified as a hospital)
- The Retail Store designation for buildings does *not* include enclosed malls, entire strip malls, or electronic stores. This building designation does however include anchor stores in enclosed malls, separately metered single stores within a strip mall, big box stores, etc.

Specific building types have additional physical characteristic requirements that must also be met and they are as follows.

- **Hospitals**

  This is limited to only Acute Care and Children's Hospitals. Specifically excluded are all hospitals primarily used as out-patient facilities, cancer centers, skilled nursing centers, psychiatric care hospitals, rehabilitation centers, or veterinary clinics. See **Appendix E** for definitions.

1.5 Hints & Tips:

Original specifications, design documents, and "as-built" drawings can be used to confirm certain physical characteristics. However, because the actual physical characteristics of the building can vary significantly from these plans and records, any review of documentation should always be combined with a physical inspection of the building.

1.6 Physical Characteristics Q& A:

- ***Are buildings that are owned by U. S. based companies or by the Federal Government but that are located outside of the United States eligible to apply for the ENERGY STAR label?***

Buildings located on foreign lands but owned by U.S.-based companies are not eligible to apply for the ENERGY STAR label. However, buildings that are located on foreign lands but that are owned and occupied by the United States government and that meet U.S. construction codes are eligible.

- ***Are common areas to be included when determining the floor area of the building or a***

given space (for example, office space)?

Yes, the user-entered value for area must be the gross interior area of the building, or in the case of a user-specified office block, the gross interior area of the office block. This includes all principal exterior surfaces of the enclosing fixed walls and includes all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc.
Additionally, the following must be noted:

- Existing atriums should only include the base floor area that it occupies.
- Interstitial (plenum) space between floors should not be included in total.
- Gross floor area is not the same as leasable space. Leasable space is a subset of a building's gross floor area.

- ***Can parking garage or surface parking be excluded from the analysis?***

Yes, if the energy consumption for a parking garage or surface parking is included on the same meter as the building then it should be accounted for in Portfolio Manager. The tool will calculate the energy consumption of the parking structure and subtract the energy use of the parking structure from the actual reported energy consumption. If the parking structure is separately metered and not included in other utility bill data in Portfolio Manager, the user can exclude the parking structure from Portfolio Manager.

1.7 Verifying Information on Data Checklist (NEW REQUIREMENT)

The Data Checklist is a new document (as of October 2008) developed by EPA that prints out with the Statement of Energy Performance from Portfolio Manager. The document is meant to summarize all building information for both the owner/operator of the building and the Professional Engineer. The document is especially meant to assist the Professional Engineer during the site visit of the label application process by providing all the information about the building in question including physical, operational, and energy information. During the site visit, the PE must verify that all information listed on the Data Checklist (and SEP) is true and accurate. In addition to stamping that all information listed on the SEP is true and accurate, the PE must also sign and date the Data Checklist for purposes of applying for the ENERGY STAR label (*effective October 25th 2008*). A complete data checklist will include a check and/or notation in the box provided by each item. Below are a few examples of physical characteristics that must be verified by the PE:

- Building Name
- Type of Office
- Location
- Single Structure
- Gross Floor Area

Module 2: Operating Characteristics

2.1 Objective:

All recorded operating characteristics displayed on a building's Statement of Energy Performance must be verified when applying for the ENERGY STAR label.

2.2 Background and Expectations of PE:

To assess the energy performance of a building, all building operating characteristics must be accurately portrayed by the user. Operating characteristics include rates of occupancy and vacancy among other pertinent characteristics specific to each building type. The PE is expected to verify the accuracy of the building's recorded operating characteristics displayed on the Statement of Energy Performance and verify that the building meets the eligibility requirements for the ENERGY STAR label. A checklist of the items to be verified is provided at the end this module.

2.3 Operating Characteristic Requirements:

Eligibility requirements must be met before a building can qualify for the ENERGY STAR label. In Portfolio Manager, users are asked to enter data for key operating characteristics of their building. There are minimum and maximum thresholds for these values. These limits are designed to make sure that their building falls into an operation pattern consistent with that of the peer group of buildings used for comparison. In order to be eligible to receive a national energy performance rating and qualify for the ENERGY STAR label, these threshold values must be met. The following requirements must be verified by the PE.

- All buildings must:
  - be in operation at least 30 hours per week
  - be at least 5,000 ft^2, with two exceptions:
    - If the building is a bank, it may be as small as 1,000 square foot
    - If the building is a hospital, it must be at least 20,000 square foot
  - have at least 11 consecutive months of energy data and operational characteristics
  - must contain at least 1 worker during the main shift (does not apply for hospitals or any other building type that does not have "Workers on Main Shift" listed as a required operational characteristic)
- All office, bank, courthouse, and K-12 school spaces must contain at least 1 Personal Computer (PC). Retail stores must contain at least 1 register but can have 0 personal computers.
- Building must meet the following occupancy requirements:
  - Offices must have at least 75% average annual occupancy
  - Hotels cannot have greater than 45% average annual vacancy
  - Schools must operate for at least 8 months of the year
- If the facility is a hospital, it must include:
  - At least 16 licensed beds but no more than 1,510 beds and
  - No more than 40 floors
- If the facility is a supermarket, it must include:
  - At least one worker on the main shift
  - At least one walk-in refrigerator/freezer unit
- Residence halls/Dormitories must contain at least 5 rooms.

- If the facility is a hotel, it must include at least one room

2.4 Hints & Tips:

- For office buildings, it can be useful to contact the building's local area network (LAN) manager or the equivalent to find out the average number of workers and number of PCs throughout the year, and the typical weekly operating hours.

- Because HVAC systems are often scheduled to operate for a period of time before and after the typical period of occupancy, using data from an automated environmental management system can substantially overstate the weekly operating hours as defined in Portfolio Manager. "Weekly operating hours" is defined by the number of hours during the week the building is 75% occupied.

2.5 Operating Characteristics Q& A:

- ***Are the weekly operating hours the same as the hours that the HVAC system is operating, including start-up and shut-down periods?***

No. Weekly operating hours are defined as the number of hours per week in which the majority of the primary tenants (workers for office buildings, customers for grocery stores/ supermarkets, and students for K-12 schools) are within the confines of the building. Note: Typically the operating hours of hotels and hospitals are 168 hours per week.

- ***Does an employee kitchen or galley count as a cooking facility*?**

No. In Portfolio Manager this question is used to determine whether it contains a cooking facility, such as a cafeteria, where food is prepared and served to the primary occupants, customers, or guests. Employee kitchens and galleys are outside the intent of this question. Cafeterias that serve only to keep food warm that was prepared elsewhere should not be considered cooking facilities.

- ***How should office buildings that have a large (for example, one half of one full floor), full-service cafeteria within the main office building structure be handled? Is this space considered part of the primary office space or is it considered another space type, such as restaurant?***

Yes, if the space serves the office building, then it is considered part of the office space and should not be separated out. If this cafeteria space is unrelated to the office building and is considered an independent operation such as a separate restaurant or catering service, than it should be entered into Portfolio Manager as "other". In this case, if the space is sub-metered and less than 10% of the total square foot of the building, then the energy consumption can be separated out.

- ***Is the PE expected to count each required input such as occupants, PCs, or rooms to verify the quantity in a given space****?*

No. The PE may verify this information by asking credible parties who have a detailed knowledge of the building or cross-checking information within a Portfolio Manager account. However, it is good practice to verify in person any questionable information. Additionally, all physical and operating characteristics of the building must be verified in some form. To aid this process, please see the checklist provided at the end of the document.

2.6 Checklist: Verification of Operating Characteristics of a Building (NEW REQUIREMENT)

- For more on the verification process of the Data Checklist (new PE requirement for purposes of applying for the ENERGY STAR label (*effective October 25th 2008*) please refer to Section 1.7 .

Module 3: Energy Consumption

3.1 Objective:

All recorded energy consumption for each type of fuel used within a building must be verified on a Statement of Energy Performance for a building applying for the ENERGY STAR label.

3.2 Background and Expectations of PE:

To assess the performance of a building, all sources of energy within the building must be entered and verified through Portfolio Manager. Currently, acceptable fuel sources include the following: electricity, natural gas, fuel oil, diesel fuel, district steam or hot water, district chilled water, propane, coal, coke, kerosene and wood.

On-site electricity production and on-site renewable energy should be treated from the perspective of the curb. That is, only energy that crosses the curb and enters the building should be included. On-site generation of electricity typically consumes either natural gas or diesel fuel. In this case, include the consumption of natural gas or diesel fuel, but do NOT include the amount of electricity generated on-site. Renewable energy generated on-site would not be included because no energy flows across the curb. Effectively, renewable energy acts to offset the consumption of energy that would otherwise cross the curb.

Buildings or facilities that distribute energy produced on-site to other buildings or onto the electricity grid should remove the impact of this additional energy use. To accomplish this, a meter should be included in the Portfolio Manger record as having negative monthly values for each fuel type that is leaving the building for consumption off-site at another location. Similarly, if a building shares fuel with an adjacent building (e.g. district heat or cooling), that fuel must be apportioned and metered according to each building's actual consumption.

The PE is expected to review energy consumption documentation for each energy source used in the building to validate the energy consumption values reported on the SEP and Data Checklist. Documentation must include monthly energy consumption for each energy source spanning the most recent 12 months including dates of each entry. The PE must also verify that no fuel was excluded. Each item must be verified to be true and accurate on the Statement of Energy Performance and Data Checklist.

3.3 Hints & Tips:

First, review actual monthly energy bills provided by the management or owners. Other sources of energy consumption data, such as spreadsheet tracking and Energy Management Control System (EMCS) output, might be incomplete or not record all fuels or meters within the building.

Before reviewing the building record on the SEP and Data Checklist or performing the building walk-through you should do the following:

- Get copies of actual energy bills and any record of monthly EMCS output.
- Determine the number of energy sources used within the building.
- Ask about the energy sources for any equipment that uses something other than electricity (for example, domestic water heaters and back-up electrical generators).

3.4 Energy Consumption Q& A:

- ***To verify the monthly energy consumption, must monthly bills from the utility company be independently obtained?***

No. If the PE is confident based on his/her walk-through that all of the energy sources and meters are accounted for, than independently obtained monthly utility bills are not required. In all but the rarest of cases, the review of existing monthly energy bills that have been provided by the building management or owner is sufficient.

- ***Are monthly utility bills needed to verify the monthly energy consumption of each fuel?***

No. Based upon the judgment of the PE, a building-wide, energy-tracking tool that fully tracks consumption of all fuels (such as an EMCS) may be used instead of utility bills.

- ***Are simulated or calculated values for monthly energy consumption acceptable?***

No. Simulated or calculated values for monthly energy consumption are not acceptable when applying for the ENERGY STAR label.

- ***Should the electrical outputs of on-site renewable sources or co-generation units be included as part of the building's monthly energy consumption?***

No. Full credit is given for the use of on-site renewables. The energy input required by the co-generation unit must be accounted for in Portfolio Manager, but not the electricity that is generated.

- ***What if the facility sells or distributes energy to other buildings (that is, the benchmarked building makes and distributes hot water, steam, chilled water, or electricity to adjacent buildings)?***

Portfolio Manager is able to account for energy consumed by the building and distributed to other entities. This is accomplished by creating a meter with negative values for each fuel type that is leaving the building for consumption off-site.

3.5 Checklist: Verification of Energy Consumption (NEW REQUIREMENT)

- For more on the verification process of the Data Checklist (new PE requirement for purposes of applying for the ENERGY STAR label effective [DATE] 2009) please refer to Section 1.7.

Module 4: Thermal Comfort

4.1 Objective:

The PE must verify that the thermal conditions in a building conform to industry standards as part of the review for the ENERGY STAR label, to help assure that a comfortable work environment has not been sacrificed to reduce energy use.

4.2 Technology Standard:

ANSI/ASHRAE Standard 55: Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta Georgia. www.ashrae.org Earlier versions of the Standard may be used, when properly referenced in building documents, if appropriate in the PE's professional judgment

4.3 Background and Expectations of PE:

According to ASHRAE Standard 55, acceptable thermal environment of indoor spaces designed for human occupancy is dependent upon temperature, relative humidity, air speed, building activity, and clothing insulation. Thermal comfort may also vary from person to person; however, extensive laboratory and field data have been collected by ANSI/ASHRAE to provide necessary statistical data to define conditions that a specified percentage of occupants will find thermally comfortable. The majority of data collected is thermal comfort data that pertains to sedentary or near sedentary physical activity levels typical of office work. The PE is expected to verify on the Statement of Energy Performance that thermal comfort conditions of the building are met given the standards outlined in ANSI/ASHRAE Standard 55. It is the responsibility of the PE to consider all measured data and observations at the time of the site visit and to determine, in his/ her professional opinion, whether the building meets the letter and spirit of ASHRAE Standard 55.

4.4 Acceptable Thermal Environmental Conditions:

There are two methods for determining acceptable thermal conditions in occupied spaces as outlined by ASHRAE Standard 55. One method is based on a typical indoor environment with set conditions, and the other method assesses thermal conditions in naturally conditioned spaces. Naturally conditioned spaces are those spaces controlled by occupants through the opening and closing of windows. Given these different methods, the PE is expected to give a professional opinion about the capability of the building to provide acceptable thermal environment conditions per guidelines provided by ASHRAE Standard 55. The PE should measure the temperature, relative humidity, air speed, and draft of a representative sample of the occupied interior spaces of the building during occupied hours. Please refer to ASHRAE Standard 55 for guidance on acceptable limits of these conditions that are expected to be maintained within a functioning building.

4.5 Hints & Tips:

Reviewing previous indoor air quality reports or testing, adjusting, and balancing (TAB) reports is generally not acceptable as a sole source of information when giving a professional opinion about whether the building can provide acceptable thermal environmental conditions.

It is highly recommended that the PE, as part of the evaluation of the occupied spaces, observe and record such signs of possible occupant thermal discomfort as:

- Oscillating table fans, window fans, or other personal fans
- Personal space heaters
- Open windows (unless it is an occupant-controlled, naturally conditioned space)
- Window or through-the-wall style room air-conditioners
- Covered or otherwise occupant-modified supply air diffusers
- Altered or broken thermostats

In addition to observing the conditions, the PE should take temperature and humidity measurements in occupied areas that have the highest concentration of the items listed above. This is a good way to check the most problematic occupied areas in the building. Again, it is up to the PE's professional judgment as to whether the building as a whole provides a suitable work environment for those subject to the respective working conditions. The outlined standards for acceptable conditions are meant to provide general guidance.

For hotels having individual room units for comfort air and a separate system for outdoor air, make sure that the systems can simultaneously provide comfort AND proper ventilation.

4.6 Thermal Comfort Q& A:

- ***Must the building be assessed as it operates in both heating and cooling modes?***

No. The capability of the building to meet ASHRAE Standard 55, for the purposes of the Statement of Energy Performance, should be determined based on the mode of the HVAC system at the time of the assessment. However, the presence and prevalence of personal comfort items noted above should always factor into the decision of the PE as to whether or not both heating and cooling systems are operating as intended.

- ***Are temperature and humidity measurements required for every occupied space within the building?***

No. The PE should take a representative sample of the occupied spaces. Several factors might influence a PE's decision or require further measurement. For example, if many of the spaces measured are barely meeting the temperature and humidity conditions, then more measurements may be needed. Similarly, if there are a significant number of personal comfort devices (for example, fans, heaters and window a/ c units) or damaged and/ or occupant-altered HVAC equipment (for example, diffusers and thermostats), the PE should consider additional measurements in these areas.

- ***If the measured temperature and/ or humidity of a single occupied space are outside the acceptable thermal conditions listed in ASHRAE Standard 55, is that in and of itself grounds to "fail" the thermal comfort check?***

Generally, no. The assessment of thermal comfort should take into account all measurements and observations, and does not depend upon one occupied space not meeting the temperature and humidity requirements. After considering all measured data and observations, it is the responsibility of the PE to determine whether the building meets the letter and spirit of ASHRAE Standard 55.

- ***Why are TAB reports and Indoor Air Quality (IAQ) assessments generally not acceptable to assess whether acceptable thermal environmental conditions are being met?***

There are two reasons: 1) the assessment is intended to be a professional opinion at the time of the site visit; and 2) the assessment is intended to be based on the measurements and observations of the PE hired to perform the assessment. TAB reports and IAQ assessments can be useful for the PE to review because they may give confirmation of the PE's measurements and observations as well as indicate problem areas that need further assessment or measurement.

Module 5: Illumination

5.1 Objective:

Appropriate illumination of interior occupied spaces and the generally unoccupied exterior spaces (for example, parking garages and parking lots) associated with the building must be verified as part of review for the ENERGY STAR label. Appropriate illumination is defined by current industry standards for commercial illumination.

5.2 Technology Standard:

IESNA, Lighting Handbook: Reference & Application, 9th Edition. Illuminating Engineering Society of North America (IESNA) 120 Wall Street, 17th Floor, New York, NY 10005.

5.3 Background and Expectations of PE:

According to the Illuminance Selection Procedure of the IESNA Lighting Handbook, illuminance levels for specific applications are based on best practices for a "typical" application. While illuminance is not the sole, or in many cases the most important lighting design criteria, it is a useful indicator to determine if the lighting system performance has been compromised in pursuit of energy conservation.

The PE is expected to give a professional opinion about the capability of the building to provide minimum recommended illumination levels of both occupied spaces (that is, interior spaces) and generally unoccupied spaces (that is, parking garages and parking lots) based on guidance provided by the Illuminance Selection Procedure in the IESNA Lighting Handbook. In doing so, the PE should measure the illumination levels in a representative sample of the occupied interior spaces of the building as well as any associated parking facilities. It is the responsibility of the PE to decide, based on his/ her professional opinion, whether the building meets the minimum recommended illumination levels considering all measured data and observations at the time of the site visit.

5.4 Acceptable Illumination Levels:

The IESNA Lighting Handbook recommends horizontal and/ or vertical task illuminances for a wide variety of locations and tasks. The recommended values throughout the IESNA Lighting Handbook represent consensus values formally obtained by the appropriate application committee. IESNA recognizes that illuminance is not the sole lighting design criterion and that other criteria may be more important than illuminance. In these instances, the lighting designer may deviate from the recommended illuminance. In general, IESNA believe that a dramatic difference between actual and a recommended illuminance (i.e. a difference of two standard deviations or more) is characterized as 1/3 more or 1/3 less than the recommended value. Any dramatic deviations from the recommended value should be carefully documented just in case the design is ever challenged. Additionally, it should be kept in mind that while a single instance is not alarming, a number of dramatic deviations should be questioned and challenged against the design illuminance. A sample of the minimum recommended illumination levels in foot-candles (FC) are given in the table below. Please refer to the IESNA Lighting Handbook for a complete list of recommended illumination levels of interior spaces.

Recommended Illumination Levels for Interior Spaces

Note this list is not all inclusive. For a complete list of recommended illumination levels of interior spaces, see Interior 1-16 of the IESNA Lighting Design Guide.

Space Type	Horizontal (FC)	Vertical (FC)
Offices		
Meeting Rooms	30	5
Video Conference Rooms	50	30
Copy Rooms	10	3
Mail Sorting	50	3
Private Offices	50	5
Open Plan Offices	30 to 50	5
Lobbies/ Reception Areas	10	3
Stairways and Corridors	5	-
Restrooms	5	3
Educational Facilities		
Reading -- white boards	-	5
Reading – chalk boards	-	50
Reading – pen/ typed print/# 2 pencil	30	-
Reading -- keyboard	30	-
Science Labs	50	30
Art Rooms	50	30
Lecture Halls	100	50
Health Care Facilities		
Anesthetizing	50	10
Autopsy, general	50	10
Cardiac function laboratory	50	10
Work areas, general	30	5
Operating areas, delivery, recovery, & lab suite and service	50	3
Critical care areas	5	3
Recovery room, general	10	3
Emergency outpatient general	50	10
Occupational therapy	30	5
Patient rooms, observation	5	3
Surgical Suite, general	300-1000	50
Surgical Holding Room	50	10

Space Type*	Horizontal (FC)	Vertical (FC)
Hotels		
Guest rooms – general	10	-
Bathrooms	30	5
Corridors, elevators, stairs	5	-
Front desk	50	-
Lobby – general lighting	10	-
Linen room – general	10	-
Retail		
Fitting areas	100	30
Stocks rooms, wrapping, packaging	30	5
General merchandise display	50	10
Supermarkets		
Shelving	50	10
Meat - processed	50	10
Meat -fresh	50	10
Produce	50	10
Dairy	50	10

Parking Facilities and Enclosed Parking Garages:

The illuminance requirements for all parking facilities depend largely on pedestrian needs and perceived personal security issues. Lighting for parking lots should provide not only the recommended minimum illuminance levels but also good color, rendition, uniformity, and minimal glare. From a security standpoint, lighting for parking garages need higher illuminances than open parking facilities. Good lighting uniformity is most important in parking garages since access aisles are used by pedestrians for

walking between cars, stairways and elevators. The recommended maintained illuminance levels for both open parking lots and enclosed garages are noted below.

Recommended Maintained Illuminance Values for Parking

	Minimum Horizontal (fc)	Minimum Vertical (fc)
Open parking lots		
Basic	0.2	0.1
Enhanced Security	0.5	0.25
Parking garages		
Basic	1.0	0.5
Ramps		
Day	2.0	1.0
Night	1.0	0.5
Entrance Areas		
Day	50.0	25.0
Night	1.0	0.5
Stairways	2.0	1.0

5.5 Hints & Tips:

- When measuring illuminance, remember to position the light meter at the proper height on the work surface at the task location (either vertical or horizontal). Avoid shadowing the meter with your body, and avoid reflections off of clothing.
- Allow thirty minutes between system switch-on and the first measurement to ensure that the lighting system has reached a stable condition.
- Daylight effects should be eliminated by performing the lighting survey after dark, or with the blinds closed and measuring the day lighting contribution with the lights off and subtracting its contribution to the electric lighting.
- Illumination should be checked both directly under the fixture and between fixtures (both laterally and longitudinally).
- Uniformity should also be evaluated, particularly next to walls, in corners, and parking garages where security and safety might be of question.
- Areas with occupant-supplied task lights, de-lamped fixtures, or numerous burned-out lamps should receive additional scrutiny as these are areas that may be under lit.
- The PE should be able to make a professional judgment on whether appropriate illumination exists through a subset of measurements in a representative sample of spaces within the building.

5.6 Illumination Q& A:

- ***If the measured illumination levels of a single occupied space are below the minimum recommended levels as defined in the IESNA Lighting Handbook, is that, in and of itself sufficient grounds to "fail" the building for inadequate illumination?***

Generally no, the assessment of illumination should take into account measurements and observations of all spaces, and is not necessarily contingent upon one occupied space meeting the minimum recommended levels. Based on observations at the time of the site visit, the PE must determine whether the building lighting system meets the minimum recommended illumination levels for the current occupancy.

Module 6: Ventilation for Acceptable Indoor Air Quality

6.1 Objective:

The PE must verify that minimum ventilation rates and acceptable indoor air quality are provided according to industry standards, as part of the review for the ENERGY STAR label, to help assure that indoor air quality has not been sacrificed to reduce energy use.

6.2 Technology Standard:

ANSI/ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality. *Note: Healthcare facilities may use either ASHRAE Standard 62 or AIA 2001Guideline for Design and Construction of Hospital and Healthcare Facilities.* Earlier versions of the Standard may be used, when properly referenced in building documents, if appropriate in the PE's professional judgment

6.3 Background and Expectations of PE:

According to ASHRAE Standard 62.1, acceptable indoor air quality refers to air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction. The stated purpose of the standard is to specify minimum ventilation rates and indoor air quality that is acceptable to human occupants and that minimizes adverse health effects[3]. The standard also points out that acceptable indoor air quality may not be achieved in all buildings meeting the requirements of the standard for one or more of the following reasons: Because of the diversity of sources and contaminants in indoor air, because of the many other factors that may affect occupant perception and acceptance of indoor air quality, such as air temperature, humidity, noise, lighting, and psychological stress; because of the range of susceptibility in the population; and because outdoor air brought into the building may be unacceptable or may not be adequately cleaned[4]. Furthermore, the standard does not prescribe specific ventilation rate requirements for spaces that contain smoking or that do not meet the requirements in the standard for separation from spaces that contain smoking.

The standard describes two different compliance paths, one based on ventilation rates (Ventilation Rate Procedure) and the other based on analysis of contaminant sources (IAQ Procedure). Most designers use the ventilation rate procedure. The standard includes additional requirements related to certain sources, including outdoor air, construction processes, moisture, and biological growth, regardless of which compliance path is selected for determining minimum ventilation rates.

Given proper measurements and observations, the PE is expected to give a professional opinion about the capability of the building to supply adequate ventilation rates for the maintenance of acceptable indoor air quality. Ultimately, it is the responsibility of the PE to determine, based on his/ her professional opinion, whether the building meets the letter and spirit of ASHRAE Standard 62.1 considering all measured data and observations at the time of the site visit.

6.4 Acceptable Indoor Air Quality and Ventilation Rates:

As mentioned above, ASHRAE Standard 62.1 provides details on two ventilation system design paths,

[3] Section 1.1.1 of ANSI/ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality.
[4] Section 1.2.7 and 1.2.9 of ANSI/ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality.

each subject to their own restrictions. The first ventilation system design path is based on a *Ventilation Rate Procedure*. This is a prescriptive procedure in which outdoor air intake rates are determined based on space type/application, occupancy level, and floor area. Minimum ventilation rates for people-related sources and area-related sources are based on contaminant sources and source strengths that are typical for most space types, as listed in Table 6.1 of ASHRAE Standard 62.1, Section 6.2. Table 6.1 is not shown here because the values in the table are not valid in isolation; they must be used in conjunction with other applicable requirements of the standard.

The second type of design compliance is based on the *Indoor Air Quality (IAQ) Procedure* in which outdoor air intake rates and other system design parameters are based on an analysis of contaminant sources, contaminant concentration targets, and air quality acceptability targets. In other words, controls that remove contaminants (e.g., air cleaning devices) or controls that can reliably demonstrate the maintenance of acceptable indoor air quality (resulting in indoor contaminant concentrations equal to or lower than those achieved using the Ventilation Rate Procedure) are given credit. For each contaminant of concern, a target concentration limit and corresponding exposure period should be specified. Section 6.1.2 of ASHRAE Standards 62.1 outlines what design approaches can be used to determine or validate the acceptability of minimum space and system outdoor airflow rates and other relevant design parameters. Other specifics on the IAQ Procedure can be referenced in Section 6.3 of ASHRAE Standard 62.1. Furthermore, guidelines for contaminant concentrations can be found in Appendix B of ASHRAE Standard 62.1.

Sample calculations for determining the required outdoor air supply rates can be found in the 62.1 User's Manual (ASHRAE). For healthcare facilities using the AIA 2006 Guideline in place of ASHRAE Standard 62.1, see **Appendix F** for outdoor air supply rates of various healthcare space functions.

Additionally, the PE should document any spaces failing to meet the following criteria:

- *Microbiological Sources*: The building should be free of visible signs of microbiological sources such as mold and mildew.

- *Water Intrusion:* Water intrusion or accumulation in ventilation system components such as ducts, plenums, and air handlers should be investigated and rectified.

6.5 Hints & Tips:

- Reviewing the most current, written, preventative maintenance plan can provide useful insight about the level of concern placed upon the control of indoor air pollutants. A well written preventive maintenance plan should document the procedures used in the building to monitor, inspect, and clean all HVAC components for proper operation.

- Reviewing previous indoor air quality reports or testing, adjusting, and balancing (TAB) reports is generally not acceptable as the sole means to give a professional opinion about the capability of the building to provide acceptable outside air.

- The PE should make an effort to measure the outdoor airflow directly. If this is not feasible due to air-handling unit design or configuration, the PE should calculate the percentage of outdoor air by mass balance equations.

- In buildings having repetitive occupant and HVAC configurations, direct measurement of a sampling of air-handling units may be acceptable. Each air-handling unit, however, should be inspected to determine if it is operating properly.

- Central energy management control systems (EMCS) or direct digital control (DDC) systems can provide real-time information about an air-handling unit's operating status. PEs may use this

information at their discretion as a means to give an opinion about the ability of the building to meet ASHRAE Standard 62.1.

6.6 Ventilation for Acceptable Indoor Air Quality Q&A:

- ***Is the building required to be mechanically ventilated to meet ASHRAE Standard 62.1?***

Generally, yes. However, some buildings (for example, K-12 schools) were designed to be naturally ventilated. Use of natural ventilation systems designed in accordance with Section 5.1 of ASHRAE Standard 62.1, is permitted in lieu of or in conjunction with mechanical ventilation systems. Natural ventilation must be approved by the authority having jurisdiction. Determining whether such buildings meet mechanical ventilation requirements of ASHRAE 62.1 would necessitate a calculation by the PE.

- ***Are outside air measurements or calculations required for every occupied space within the building?***

No. It is expected that the PE will take a representative sample of the occupied spaces to be able to give his/her decision. There are several factors that might influence a PE's decision or warrant further measurement. For example, if a significantly sized space is marginally meeting the minimum requirements, then more measurements may be warranted. Similarly, if there are a significant number of personal fans, indicating stagnate air, or damaged and/or occupied-altered HVAC equipment (for example, diffusers and thermostats), the PE may want to consider additional measurements in these areas.

- ***If the measured outdoor air supply of a single occupied space is below the acceptable supply rates given in ASHRAE Standard 62.1, is that sufficient grounds to give an opinion of "Fail" for the ventilation requirement?***

The answer depends upon the space itself and the compliance design path chosen (IAQ or Ventilation Rate Procedure); it is ultimately the judgment of the PE. For Example, if the ventilation rate in an open office plan within a given building does not meet ASHRAE Standard 62.1, then it would be expected that the PE would give the building a “fail” grade for the ventilation requirement. However, if the outdoor supply rate or contaminant concentration for a single private office within a whole building does not meet ASHRAE Standard 62.1 and the remainder of the building is deemed to meet the standard, than one could reasonably expect that the PE would give the building a "pass" for the ventilation requirement. Generally the outdoor air supply assessment and contaminant concentration guideline should take in to account all measurements and observations, and is not necessarily contingent upon one occupied space meeting the ventilation requirements. It is the responsibility of the PE to determine whether the building meets the letter and spirit of ASHRAE Standard 62.1 after considering all measured data and observations.

- ***Why are TAB reports and Indoor Air Quality assessments generally not acceptable for assessing whether acceptable outside air ventilation is being provided?***

The principal reasons are two-fold: 1) the assessment is intended to be a professional opinion at the time of the site visit; and 2) the assessment is intended to be based upon the measurements and observations of the PE hired to perform the assessment. TAB reports and IAQ assessments can be quite useful for the PE to review though as they may provide confirmation of the PE's measurements and observations as well as indicate problematic areas worthy of the PE's attention.

- ***Is the use of other standards or guidelines acceptable in evaluating “outside air ventilation” requirements?***

All building types are subject to ASHRAE Standard 62.1 with one exception. Healthcare facilities may use either ASHRAE Standard 62.1 OR AIA 2006 Guideline for Design and Construction of Hospital and Healthcare Facilities.

Appendix A: Contact Information

Mailing Address:

ENERGY STAR Label for Buildings
U. S. Environmental Protection Agency (6202J)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Contact information for questions:

- **E-mail:** energystarbuildings@epa.gov
- **Web-site:** www.energystar.gov (Go to *Buildings and Plants*)
  - More on Portfolio Manager: http://www.energystar.gov/benchmark
  - Applying for the ENERGY STAR Label: http://www.energystar.gov/eslabel

Technology Standards Referenced in The Guide:

- American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) Publication Sales Department 1791 Tullie Circle, NE Atlanta, GA 30329 Tel: (404) 636-8400 Web URL: www.ashrae.org ASHRAE standards are updated on a continual basis. EPA recommends that a Professional Engineer use the latest version of these standards when undergoing the review process for an ENERGY STAR label application.
  - ANSI/ASHRAE Standard 55-2004: Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta Georgia. www.ashrae.org
  - ANSI/ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta Georgia. www.ashrae.org

  Note: Healthcare facilities may use either ASHRAE Standard 62 or AIA 2006 Guideline for Design and Construction of Hospital and Healthcare Facilities.
- IESNA, Lighting Handbook: Reference & Application, 9th Edition Illuminating Engineering Society of North America (IESNA) 120 Wall Street, 17th Floor New York, NY 10005 Tel: (212) 248-5000 Web URL: www.iesna.org E-mail: iesna@iesna.org

Appendix B: Professional Engineer Qualifications

To validate the Statement of Energy Performance, a Professional Engineer (PE) must possess a current license and be in good standing. The PE should also have:

- A license in a discipline related to commercial building systems, such as mechanical or electrical engineering and
- Working knowledge of building systems, ASHRAE Standard 55, ASHRAE Standard 62.1, and the IESNA Lighting Handbook.

Territorial engineering licensure laws and regulations vary from jurisdiction to jurisdiction. Before offering or performing services, it is recommended that PE's understand the engineering professional practice and ethics requirements contained in the state and territorial laws and regulations.

STATEMENT OF ENERGY PERFORMANCE
Sample Facility

Building ID: 1526045
For 12-month Period Ending: July 31, 2008[1]
Date SEP becomes ineligible: November 28, 2008
Date SEP Generated: October 29, 2008

Facility
Sample Facility
1234 Main Street
Charlotte, NC 28227

Facility Owner
Sample Owner
1500 Test Avenue
Charlotte, NC 28227
555-555-5555

Primary Contact for this Facility
Jane Smith
1500 Test Avenue
Charlotte, NC 28227
555-555-5555
jsmith@jsmith.com

Year Built: 2001
Gross Floor Area (ft²): 12,000

Energy Performance Rating[2] (1-100) 100

Site Energy Use Summary[3]

Electricity (kBtu)	478,492
Natural Gas (kBtu)[4]	0
Total Energy (kBtu)	478,492

Energy Intensity[5]

Site (kBtu/ft²/yr)	40
Source (kBtu/ft²/yr)	1

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	1

Electric Distribution Utility
Duke Energy Carolinas, LLC

National Average Comparison

National Average Site EUI	65
National Average Source EUI	217
% Difference from National Average Source EUI	-39%
Building Type	Office

Professional Engineer Stamp
I certify that the information contained within this statement is accurate and in accordance with the PE Guidelines.

Professional Engineer Stamp

Signature: _____

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate and in accordance with the PE Guidelines.

Meets Industry Standards[6] **for Indoor Environmental Conditions:**

Ventilation for Acceptable Indoor Air Quality	**Yes**
Acceptable Thermal Environmental Conditions	**Yes**
Adequate Illumination	**Yes**

Professional Engineer
License Number: 0000203
State: NC
John Doe
33 Country Lane
Charlotte, NC 28227
555-555-7788

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Natural Gas values in units of volume (e.g. cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
5. Values represent energy intensity, annualized to a 12-month period.
6. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, PE facility inspection, and notarizing the SEP) and welcomes suggestions for reducing this level of effort. Send comments (referencing OMB control number) to the Director, Collection Strategies Division, U.S., EPA (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.
NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	Sample Facility	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	Office	Is this an accurate description of the space in question?		☐
Location	1234 Main Street, Charlotte, NC 28227	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Annual Occupancy Rate	90 %	Has the property maintained an average occupancy of 75% or higher across the 12 month period being assessed?		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of acute care or children's hospitals) nor can they be submitted as representing only a portion of a building		☐
Exhibition Office (Office)				
CRITERION	**VALUE AS ENTERED IN PORTFOLIO MANAGER**	**VERIFICATION QUESTIONS**	**NOTES**	☑
Gross Floor Area	12,000 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Weekly operating hours	50 Hours	Is this the total number of hours per week that the Office space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		☐
Workers on Main Shift	45	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100. The normal worker density ranges between 0.3 and 10 workers per 1000 square feet (92.8 square meters)		☐
Number of PCs	45	Is this the number of personal computers in the Office?		☐
Percent Cooled	50% or more	Is this the percentage of the total floor space within the facility that is served by mechanical cooling equipment?		☐
Percent Heated	50% or more	Is this the percentage of the total floor space within the facility that is served by mechanical heating equipment?		☐
Parking (Parking)				

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Gross Floor Area	12,321 Sq. Ft.	Is this the total square footage of the entire parking area (enclosed + nonenclosed + open floor area)?		☐
Enclosed Floor Area	0 Sq. Ft.	Is this the total square footage of the enclosed garage space? An enclosed garage is defined as having both sides and a roof.		☐
Non-Enclosed Floor Area (w/roof)	0 Sq. Ft.	Is this the total square footage of the nonenclosed garage space? This is typically defined as the portion of the garage above ground (contains no sides but is under a roof).		☐
Open Floor Area (w/o roof)	12,321 Sq. Ft.	Is this the total square footage of the nonenclosed parking area without a roof? This is typically defined as open parking lots or the very top level of an above ground parking garage.		☐
Weekly Hours of Access	168 Hours	Is this the total number of hours per week when it is possible for a vehicle to enter or exit?		☐

ENERGY STAR® Data Checklist for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: Duke Energy Carolinas, LLC

Fuel Type: Electricity		
Meter: Meter A (kWh) **Space(s):** Entire Facility		
Start Date	**End Date**	**Energy Use (kWh)**
07/01/2008	07/31/2008	12,034.00
06/01/2008	06/30/2008	11,500.00
05/01/2008	05/31/2008	11,000.00
04/01/2008	04/30/2008	11,600.00
03/01/2008	03/31/2008	11,970.00
02/01/2008	02/29/2008	11,800.00
01/01/2008	01/31/2008	11,752.00
12/01/2007	12/31/2007	12,003.00
11/01/2007	11/30/2007	11,702.00
10/01/2007	10/31/2007	11,800.00
09/01/2007	09/30/2007	12,054.00
08/01/2007	08/31/2007	11,023.00
Meter A Consumption (kWh)		**140,238.00**
Meter A Consumption (kBtu)		**478,492.06**
Total Electricity Consumption (kBtu)		**478,492.06**
Is this the total Electricity consumption at this building including all Electricity meters?		☐

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	☐

Certifying Professional

(When applying for the ENERGY STAR, this must be the same PE that signed and stamped the SEP.)

Name: _____ Date: _____

Signature: _____

Signature is required when applying for the ENERGY STAR.

Appendix E. List of Building Type Definitions

Bank/Financial Institution
Bank/Financial Institution applies to facility space used for financial services. Relevant businesses include bank branches, bank headquarters, securities and brokerage firms. The total gross floor area should include all supporting functions such as vaults, kitchens used by staff, lobbies, atria, conference rooms and auditoria, fitness areas for staff, storage areas, stairways, elevator shafts, etc.

Computer Data Center

Computer Data Center applies to spaces specifically designed and equipped to meet the needs of high density computing equipment such as server racks, used for data storage and processing. Typically these are raised floor spaces that maintain controlled temperatures and/or humidity. The air-conditioning system for this type of space is usually separate from that used to control the space environment in other parts of the building and is usually separated by walls and doors.

If an entire facility is listed as a Computer Data Center, it is not eligible to receive a National Energy Performance Rating. However, if the majority of the building space use falls into an eligible category and the Computer Data Center accounts for 10% or less of total floor area, the facility is eligible to receive an National Energy Performance Rating.

Courthouse
Courthouse applies to facility space used for federal, state, or local courts and associated office space. The total gross floor area should include all supporting functions such as temporary holding cells, kitchens used by staff, lobbies, atria, conference rooms and auditoria, fitness areas for staff, storage areas, stairways, elevator shafts, etc.

Dormitory / Residence Hall
Dormitory/Residence Hall applies to buildings associated with educational institutions or military facilities which offer multiple accommodations for long-term residents. The total gross floor area should include all supporting functions such as food service facilities, laundry facilities, meeting spaces, exercise rooms, health club/spas, lobbies, elevator shafts, storage areas stairways, etc.

Hospital (Acute Care and Children's)
Hospital applies to facility space used as Acute Care and Children's Hospitals between 20,000 to 5,000,000 square feet in total gross floor area. These facilities provide acute care services intended to treat patients for short periods of time for any brief but severe medical condition, including emergency medical care, physician's office services, diagnostic care, ambulatory care, and surgical care. Acute care hospitals typically discharge patients as soon the patient is deemed healthy and stable. Note: Long-term care hospitals (LTCHs) that are certified as acute care hospitals are not eligible because LTCHs provide patients with acute care for extended inpatient stays, defined by federal statute as an average of 25 days or more.

At least 51% of beds must be licensed and used for acute care services. And at least 51% of the total gross floor area must be used for acute care services. The total floor area should include all supporting functions such as: stairways, connecting corridors between buildings, medical offices, exam rooms, laboratories, lobbies, atria, cafeterias, storage areas, elevator shafts, and any space affiliated with emergency medical care, or diagnostic care. Facilities that use 51% or more of the gross floor area for

long-term care, skilled nursing, and/or ambulatory surgical centers are not eligible for a rating at this time but can benchmark within Portfolio Manager using the "Other" space type category.

No unique space uses should be entered other than parking, computer data centers, or swimming pools. All of the other facility and/or campus characteristics should be aggregated under the "Hospital (Acute care, Children's)" space use classification within Portfolio Manager.

Additional guidance: **Healthcare Classification Document** (446KB)

Hotel
Hotel applies to buildings that rent overnight accommodations on a room/suite basis, with a bath/shower and other facilities in most guest rooms. The total gross floor area should include all supporting functions such as food preparation and restaurant space, laundry facilities, conference and banquet space, health club/spas, lobbies, atria, elevator shafts, stairways, storage areas, etc.

K-12 School
K-12 School applies to facility space used as a school building for Kindergarten through 12th grade students. This does not include college or university classroom facilities and laboratories, vocational, technical, or trade schools. The total gross floor area should include all supporting functions such as administrative space, conference rooms, kitchens used by staff, lobbies, cafeterias, gymnasiums, auditoria, laboratory classrooms, portable classrooms, greenhouses, stairways, atria, elevator shafts, small landscaping sheds, storage areas, etc.

Medical Office
Medical Office applies to facility space used to provide diagnosis and treatment for medical, dental, or psychiatric outpatient care. The total gross floor area should include all supporting functions such as kitchens used by staff, laboratories, lobbies, atria, conference rooms and auditoria, fitness areas for staff, storage areas, stairways, elevator shafts, etc.

Additional guidance: **Healthcare Classification Document** (446KB)

Office
Office applies to facility spaces used for general office, professional, and administrative purposes. The total gross floor area should include all supporting functions such as kitchens used by staff, lobbies, atria, conference rooms and auditoria, fitness areas for staff, storage areas, stairways, elevator shafts, etc.

Parking
The Parking space type is intended for any area connected to the building that is used for parking vehicles. This includes parking lots, fully enclosed parking structures, and unenclosed parking structures that are open on all sides and may or may not include roof parking. All parking areas should be combined into one parking space. The purpose of combining all of these areas into one space is to avoid double counting and simplify the process. By apportioning the square foot of the parking area into these three categories, Portfolio Manager can properly assign lighting and ventilation allowances.

Retail Store
This space type applies to stores of at least 5,000 square feet in gross floor area used to conduct the retail sale of consumer products goods. The total gross floor area should include all supporting functions

such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, etc. Stores must be free standing or located in strip centers. Stores located in enclosed malls are not eligible, with the exception of mall anchors. Retail segments typically eligible for benchmarking include: Department Store, Discount Store, Supercenter, Warehouse Club, Drug Store, Dollar Store, Home Center/Hardware, and Apparel/Hard Line Specialty (i.e. books, clothing, office products, toys, home goods). Retail segments not eligible for benchmarking include Electronics Stores.

Supermarket
The Supermarket/Grocery Store space type applies to facility space used for the retail sale of food and beverage products. It should not be used by restaurants, which are not eligible for a rating at this time. The total gross floor area should include all supporting functions such as kitchens and break rooms used by staff, storage areas (refrigerated and non-refrigerated), administrative areas, stairwells, atria, lobbies, etc.

Swimming Pool
Swimming Pool applies to heated swimming pools that operate on the premises and on the same energy-use meter as the primary building. This category applies to any heated swimming pools located inside or outside of the facility. Swimming pools are categorized by size and whether they are an indoor our outdoor pool.

Warehouse (Refrigerated or Unrefrigerated)
The warehouse space type is intended to define facility space that is *only used to store* goods, manufactured products, merchandise or raw materials. Space types defined as Warehouse (Refrigerated or Unrefrigerated) must not contain any onsite manufacturing. If the space is part of an industrial campus, the space defined as warehouse must be a separate structure that is separately metered from any adjacent processing plants. Refrigerated warehouse specifically denotes space designed to store perishable goods or merchandise under refrigeration at temperatures below 50 degrees Fahrenheit. Unrefrigerated warehouse specifically denotes space designed to store non-perishable goods and merchandise. The total gross floor area should include all supporting functions such as offices, lobbies, stairways, rest rooms, equipment storage areas, elevator shafts, etc.

Appendix F: Outdoor Air Ventilation Rates for Health Care Facilities

(Healthcare facilities using the AIA 2006 Guideline in place of ASHRAE Standard 62.1)

Table 2.1-2

Ventilation Requirements for Areas Affecting Patient Care in Hospitals and Outpatient Facilities[1]

Area designation	*Air movement relationship to adjacent area[2]*	*Minimum air changes of outdoor air per hour[3]*	*Minimum total air changes per hour[4,5]*	*All air exhausted directly to outdoors[6]*	*Recirculated by means of room units[7]*	*Relative humidity[8] (%)*	*Design temperature[9] (degrees F/C)*
NURSING UNITS							
Patient room	–	2	6[10]	–	–	–	70-75 (21–24)
Toilet room	In	–	10	Yes	–	–	–
Newborn nursery suite	–	2	6	–	No	30-60	72-78 (22-26)
Protective environment room[11]	Out	2	12	–	No	–	75 (24)
Airborne infection isolation room[11]	In	2	12	Yes[12]	No	–	75 (24)
Isolation alcove or anteroom	In/Out	–	10	Yes	No	–	–
Patient corridor	–	–	2	–	–	–	–
OBSTETRICAL FACILITIES							
Delivery room[13]	Out	3	15	–	No	30-60	68-73 (20–23)
Labor/delivery/recovery	–	2	6[10]	–	–	–	70-75 (21–24)
Labor/delivery/recovery/postpartum	–	2	6[10]	–	–	–	70-75 (21–24)
EMERGENCY, SURGERY, AND CRITICAL CARE							
Operating/surgical cystoscopic rooms[11, 13]	Out	3	15	–	No	30-60	68-73 (20–23)[14]
Recovery room[13]	–	2	6	–	No	30-60	70-75 (21-24)
Critical and intensive care	–	2	6	–	No	30-60	70-75 (21–24)
Intermediate care	–	2	6[10]	–	–	–	70-75 (21–24)
Newborn intensive care	–	2	6	–	No	30-60	72-78 (22-26)
Treatment room[15]	–	–	6	–	–	–	75 (24)
Trauma room[15]	Out	3	15	–	No	30-60	70-75 (21–24)
Bronchoscopy[11]	In	2	12	Yes	No	30-60	68-73 (20–23)
Triage	In	2	12	Yes[16]	–	–	70-75 (21-24)
ER waiting rooms	In	2	12	Yes[12, 16]	–	–	70-75 (21-24)
Procedure room	Out	3	15	–	No	30-60	70-75 (21-24)
Laser eye room	Out	3	15	–	No	30-60	70-75 (21-24)
X-ray (surgical/critical care and catheterization)	Out	3	15	–	No	30-60	70-75 (21–24)
Anesthesia gas storage	In	–	8	Yes	–	–	–
SUPPORT AREAS							
Medication room	Out	–	4	–	–	–	–
Clean workroom or clean holding	Out	–	4	–	–	–	–
Soiled workroom or soiled holding	In	–	10	Yes	No	–	–
DIAGNOSTIC AND TREATMENT AREAS							
Examination room	–	–	6	–	–	–	75 (24)
Treatment room	–	–	6	–	–	–	75 (24)
Physical therapy and hydrotherapy	In	–	6	–	–	–	75 (24)
Gastrointestinal endoscopy room	–	2	6	–	No	30-60	68-73 (20–23)
Endoscopic instrument processing room[17]	In	–	10	Yes	No	–	–
Imaging[18]							
X-ray (diagnostic & treatment)	–	–	6	–	–	–	75 (24)
Darkroom	In	–	10	Yes	No	–	–
Imaging waiting rooms	In	2	12	Yes[12, 16]	–	–	70-75 (21-24)
Laboratory[19]							
General[18]	–	–	6	–	–	–	75 (24)
Biochemistry[18]	In	–	6	Yes	No	–	75 (24)
Cytology	In	–	6	Yes	No	–	75 (24)
Glass washing	In	–	10	Yes	–	–	–

Table 2.1-2 (continued)
Ventilation Requirements for Areas Affecting Patient Care in Hospitals and Outpatient Facilities[1]

Area designation	*Air movement relationship to adjacent area[2]*	*Minimum air changes of outdoor air per hour[3]*	*Minimum total air changes per hour[4, 5]*	*All air exhausted directly to outdoors[6]*	*Recirculated by means of room units[7]*	*Relative humidity[8] (%)*	*Design temperature[9] (degrees F/C)*
Histology	In	–	6	Yes	No	–	75 (24)
Microbiology[18]	In	–	6	Yes	No	–	75 (24)
Nuclear medicine	In	–	6	Yes	No	–	75 (24)
Pathology	In	–	6	Yes	No	–	75 (24)
Serology	In	–	6	Yes	No	–	75 (24)
Sterilizing	In	–	10	Yes	–	–	–
Autopsy room[11]	In	–	12	Yes	No	–	–
Nonrefrigerated body-holding room	In	–	10	Yes	–	–	70 (21)
SERVICE AREAS							
Pharmacy	Out	–	4	–	–	–	–
Food preparation center	–	–	10	–	No	–	–
Warewashing	In	–	10	Yes	No	–	–
Dietary day storage	In	–	2	–	–	–	–
Laundry, general	–	–	10	Yes	–	–	–
Soiled linen (sorting and storage)	In	–	10	Yes	No	–	–
Clean linen storage	Out	–	2	–	–	–	–
Soiled linen and trash chute room	In	–	10	Yes	No	–	–
Bedpan room	In	–	10	Yes	–	–	–
Bathroom	In	–	10	–	–	–	75 (24)
Housekeeping room	In	–	10	Yes	No	–	–
STERILIZING AND SUPPLY							
ETO-sterilizer room	In	–	10	Yes	No	30-60	75 (24)
Sterilizer equipment room	In	–	10	Yes	–	–	–
Central medical and surgical supply							
Soiled or decontamination room	In	–	6	Yes	No	–	68-73 (20–23)
Clean workroom	Out	–	4	–	No	30-60	75 (24)
Sterile storage	Out	–	4	–	–	(Max) 70	–

[1] The ventilation rates in this table cover ventilation for comfort, as well as for asepsis and odor control in areas of acute care hospitals that directly affect patient care and are determined based on healthcare facilities being predominantly "No Smoking" facilities. Where smoking may be allowed, ventilation rates will need adjustment. Areas where specific ventilation rates are not given in the table shall be ventilated in accordance with ASHRAE Standard 62, *Ventilation for Acceptable Indoor Air Quality*, and *ASHRAE Handbook–HVAC Applications*. Specialized patient care areas, including organ transplant units, burn units, specialty procedure rooms, etc., shall have additional ventilation provisions for air quality control as may be appropriate. OSHA standards and/or NIOSH criteria require special ventilation requirements for employee health and safety within health care facilities.

[2] Design of the ventilation system shall provide air movement which is generally from clean to less clean areas. If any form of variable air volume or load shedding system is used for energy conservation, it must not compromise the corridor-to-room pressure balancing relationships or the minimum air changes required by the table.

[3] To satisfy exhaust needs, replacement air from the outside is necessary. Table 2.1-2 does not attempt to describe specific amounts of outside air to be supplied to individual spaces except for certain areas such as those listed. Distribution of the outside air, added to the system to balance required exhaust, shall be as required by good engineering practice. Minimum outside air quantities shall remain constant while the system is in operation. In variable volume systems, the minimum outside air setting on the air-handling unit shall be calculated using the ASHRAE 62 method.

[4] Number of air changes may be reduced when the room is unoccupied if provisions are made to ensure that the number of air changes indicated is reestablished any time the space is being utilized. Adjustments shall include provisions so that the direction of air movement shall remain the same when the number of air changes is reduced. Areas not indicated as having continuous directional control may have ventilation systems shut down when space is unoccupied and ventilation is not otherwise needed, if the maximum infiltration or exfiltration permitted in Note 2 is not exceeded and if adjacent pressure balancing relationships are not compromised. Air quantity calculations must account for filter loading such that the indicated air change rates are provided up until the time of filter change-out. The minimum total air change requirements for Table 2.1-2 shall be based on the supply air quantity in positive pressure rooms, and the exhaust air quantity in negative pressure rooms.

[5] Air change requirements indicated are minimum values. Higher values should be used when required to maintain indicated room conditions (temperature and humidity), based on the cooling load of the space (lights, equipment, people, exterior walls and windows, etc.).

Table 2.1-2 (continued)

Ventilation Requirements for Areas Affecting Patient Care in Hospitals and Outpatient Facilities[1]

[6]Air from areas with contamination and/or odor problems shall be exhausted to the outside and not recirculated to other areas. Note that individual circumstances may require special consideration for air exhaust to the outside, e.g., in intensive care units in which patients with pulmonary infection are treated, and rooms for burn patients.

*[7]Recirculating room HVAC units refers to those local units that are used primarily for heating and cooling of air, and not disinfection of air. Because of cleaning difficulty and potential for buildup of contamination, recirculating room units shall not be used in areas marked "No." However, for airborne infection control, air may be recirculated within individual isolation rooms if HEPA filters are used. Isolation and intensive care unit rooms may be ventilated by reheat induction units in which only the primary air supplied from a central system passes through the reheat unit. Gravity-type heating or cooling units such as radiators or convectors shall not be used in operating rooms and other special care areas. See footnote A7 (at the bottom of the page) for a description of recirculation units to be used in isolation rooms.

[8]The ranges listed are the minimum and maximum limits where control is specifically needed. The maximum and minimum limits are not intended to be independent of a space's associated temperature. The humidity is expected to be at the higher end of the range when the temperature is also at the higher end, and vice versa. See Figure 2.1-1 for a graphic representation of the indicated changes on a psychrometric chart. Shaded area is acceptable range.

[9]Where temperature ranges are indicated, the systems shall be capable of maintaining the rooms at any point within the range during normal operation. A single figure indicates a heating or cooling capacity of at least the indicated temperature. This is usually applicable when patients may be undressed and require a warmer environment. Nothing in these guidelines shall be construed as precluding the use of temperatures lower than those noted when the patients' comfort and medical conditions make lower temperatures desirable. Unoccupied areas such as storage rooms shall have temperatures appropriate for the function intended.

[10]Total air changes per room for patient rooms, intermediate care, labor/delivery/recovery rooms, and labor/delivery/recovery/postpartum rooms may be reduced to 4 when supplemental heating and/or cooling systems (radiant heating and cooling, baseboard heating, etc.) are used.

*[11]Differential pressure shall be a minimum of 0.01" water gauge (2.5 Pa). If alarms are installed, allowances shall be made to prevent nuisance alarms of monitoring devices.

[12]If it is not practical to exhaust the air from the airborne infection isolation room to the outside, the air may be returned through HEPA filters to the air-handling system exclusively serving the isolation room.

[13]National Institute for Occupational Safety and Health (NIOSH) Criteria Documents regarding Occupational Exposure to Waste Anesthetic Gases and Vapors, and Control of Occupational Exposure to Nitrous Oxide indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilized.

[14]Some surgeons may require room temperatures that are outside of the indicated range. All operating room design conditions shall be developed in consultation with surgeons, anesthesiologists, and nursing staff.

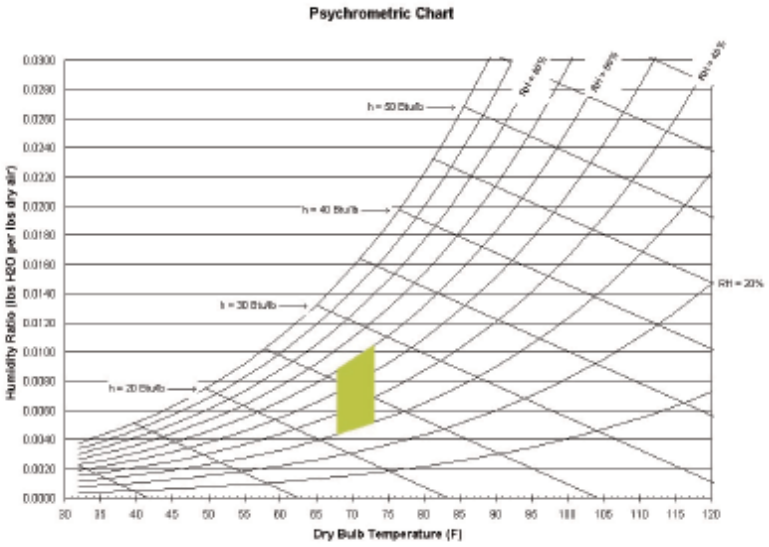
[15]The term trauma room as used here is the operating room space in the emergency department or other trauma reception area that is used for emergency surgery. The first aid room and/or "emergency room" used for initial treatment of accident victims may be ventilated as noted for the "treatment room." Treatment rooms used for bronchoscopy shall be treated as bronchoscopy rooms. Treatment rooms used for cryosurgery procedures with nitrous oxide shall contain provisions for exhausting waste gases.

[16]In a ventilation system that recirculates air, HEPA filters can be used in lieu of exhausting the air from these spaces to the outside. In this application, the return air shall be passed through the HEPA filters before it is introduced into any other spaces.

[17]The endoscopic instrument processing room is a room adjacent to the gastrointestinal endoscopy room that is used for cleaning endoscopic equipment and instruments.

[18]When required, appropriate hoods and exhaust devices for the removal of noxious gases or chemical vapors shall be provided (see Section 2.1-10.2.4.5. (2) and NFPA 99).

[19]The air movement relationships for laboratories apply between laboratory and adjacent non-laboratory spaces. Reference DHHS publication "Biosafety in Microbiological and Biomedical Laboratories" (CDC and NIH) on the CDC Web site.


Psychrometric Chart
Humidity Ratio (lbs H2O per lbs dry air)
Dry Bulb Temperature (F)
h = 50 Btu/lb
h = 40 Btu/lb
h = 30 Btu/lb
h = 20 Btu/lb
RH = 20%

Appendix G: How to Apply for the ENERGY STAR Label

How to Apply for the ENERGY STAR Label
Follow the six steps below to qualify your building as ENERGY STAR:

1. Determine if the building meets the eligibility requirements.
2. Login to Portfolio Manager and enter the required energy and building information.
3. Determine if the building achieves a rating of 75 or above.
4. Verify that all information provided on the following documents is true and accurate to the best of their ability. Both documents must be signed and dated at the time of the site visit. The Statement of Energy Performance must also be stamped by the Professional Engineer.

   A. Statement of Energy Performance:

   Determine if the building meets industry standards for comfort and indoor air quality. A Professional Engineer must verify that each of the indoor environment criteria requirements have been met and all information provided on the Statement of Energy Performance is true and accurate.

   B. Data Checklist (*New Requirement*):

   Also during the site visit, the PE must verify all information listed on the Data Checklist. The Data Checklist is meant to summarize all building information for both the owner/operator of the building and the Professional Engineer. The document is especially meant to assist the Professional Engineer during the site visit of the label application process by providing all the information about the building in question including physical, operational, and energy information.
5. Read and understand the ENERGY STAR Identity Guidelines.
6. Mail the signed Letter of Agreement and signed and stamped Statement of Energy Performance (SEP) to EPA (postmarked within 120 days of the Period Ending Date). Please note: an official Letter of Agreement will be provided for download in Portfolio Manager. Do not mail to EPA a Letter of Agreement that displays a watermark that reads SAMPLE. Please do not use company letterhead to print the Letter of Agreement.

   NOTE: The ENERGY STAR is awarded for a specific year. A building that has earned the ENERGY STAR becomes eligible to reapply one year after the last energy data included in the SEP submitted as part of the previous year's application.

ENERGY STAR Label Application for Buildings should be mailed to:
ENERGY STAR Label for Buildings
C/o The Cadmus Group, Inc.
1600 Wilson Boulevard, Suite 500
Arlington, VA 22209

Sample Building Plaques

Dimensions: width 10 inches, height 12 inches, Cyan

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, D.C. 20350-2000

110000
Ser N46/8U158464
AUG 15 2008

From: Director, Ashore Readiness Division (N46)
To: Deputy Assistant Secretary of the Navy (Environment)

Subj: PLAN OF ACTION AND MILESTONES (POA&M) FOR DEPARTMENT OF THE NAVY LOW IMPACT DEVELOPMENT (LID) IMPLEMENTAION FOR STORM WATER MANAGEMENT

Ref: (a) OPNAV N46 letter Ser /8U158437 of 8 May 08
(b) ASN(I&E) memo of 16 Nov 07
(c) DASN(E) memo of 2 Apr 08

Encl: (1) Low Impact Development Plan of Action and Milestones

1. Reference (a) states that NAVFAC will develop a POA&M for implementing storm water LID in accordance with references (b) and (c). This letter provides the NAVFAC LID POA&M, enclosure (1).

2. My point of contact for this matter is Mr. Wayne Blodgett, at wayne.blodgett@navy.mil, or 202 433-4513.

M. A. HANDLEY
Rear Admiral, CEC, U. S. Navy
Director, Ashore Readiness Division

Copy to:
COMNAVFACENGCOM (ENV, CHENG)
CNO (N45)
CMC (ENV)

Low Impact Development (LID) Plan of Action Milestones (POA&M)

The goal of the POA&M is to develop LID program requirements, policy direction, and criteria to affect the FY11 program.

3 Phase Approach

Phase 1 (JAN 08 – FEB 09)

- Goal: Issue interim guidance to assist with FY11 project 1391 development (target FEB 09)
  - Communicate the Plan and general requirements
    - » NAVFAC FEAD Awareness
  - Update Leadership in Energy and Environmental Design (LEED) training (on-line training) to expand on LID and future program requirements
  - Develop Regional requirements / approaches
    - » LANT / PAC / FECs
  - Develop interim Cost Guidance
  - Develop interim Regional Criteria Guidance
  - Send a data call on LID projects 1 Oct 2008
  - Submit LID report to DASN (E) by 15 November 2008

Phase 2 (FEB 09 – JUL 09)

- Goal: Issue Policy and Criteria for FY11 project design (target MAY/JUN 09)
  - Update UFC incorporating Regional requirements, EPA, and DASN (I&E)/Policy requirements
    - » Navy/Marine Corps only
  - Publish Policy and Criteria
    - » Engineering and Construction Bulletin (ECB) and UFC

Phase 3 (MAY 09 – SEP 09)

- Goal: Finalize Criteria and Reporting Guidance
  - Update NAVFAC Business Management System BMS, Design Build Master (DBM) templates, Performance Technical Specifications (PTS), etc.
  - Update/Refine cost guidance
  - Develop reporting/tracking – Mechanism TBD
  - Develop a waiver process

- **Follow-on requirements**
  - Develop inspection, evaluation, and maintenance processes to maintain feature viability over the design life
  - Evaluate maintenance budget impacts and develop CNIC funding needs
  - Tri-Service unification of criteria

DEPARTMENT OF THE NAVY
THE ASSISTANT SECRETARY OF THE NAVY
(INSTALLATIONS AND ENVIRONMENT)
1000 NAVY PENTAGON
WASHINGTON, D.C. 20350-1000

NOV 16 2007

MEMORANDUM FOR DEPUTY CHIEF OF NAVAL OPERATIONS
(FLEET READINESS AND LOGISTICS)
DEPUTY COMMANDANT OF THE MARINE CORPS
(INSTALLATIONS AND LOGISTICS)

SUBJECT: Department of the Navy Low Impact Development (LID) Policy for Storm Water Management

References: (a) 33 United States Code 1251 (Clean Water Act)
(b) Title 40 Code of Federal Regulations 122, 130
(c) Department of Defense Unified Facilities Criteria 3-210-10 Design for Low Impact Development, October 2004
(d) Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Management", January 2007
(e) OPNAVINST 5090.1C, Clean Water Ashore Requirement, October 2007
(f) MCO P5090.2A, Water Quality Management, July 1998

BRAC 05 implementation, Department of Defense (DoD) Grow the Force Initiatives, and ongoing installation sustainment and modernization, have resulted in significant construction activity on Department of the Navy (DON) installations. New construction results in loss of natural vegetation cover and drainage capacity and increased storm water runoff. Conventional storm water collection and conveyance systems and storm water treatment options do not and can not replicate natural systems, thus increasing the volume and flow of storm water as well as sediment and nutrient loadings to streams, wetlands, and other receiving water bodies. Because of continuing water quality problems, States and the US Environmental Protection Agency are considering mandatory treatment and control of storm water. Conversely, low impact development (LID) techniques offer a suite of Best Management Practices that maintain or restore predevelopment hydrology. It mitigates the adverse effects of construction projects on water quality by cost effectively reducing the volume and pollutant loading of storm water before it reaches the receiving water bodies. LID utilizes strategies that infiltrate, filter, store, evaporate, and/or retain runoff close to its source. LID further reduces installation reliance on aging storm water management infrastructure. References (a) thru (f) provide requirements and guidance for LID.

This DON policy sets a goal of no net increase in storm water volume and sediment or nutrient loading from major renovation and construction projects[1]. In order to support this goal, as well as reduce reliance on conventional storm water collection systems and treatment options, this policy directs that LID be considered in the design for all projects that have a storm water management element. LID will be implemented where possible to assist DON installations in complying with references (a) and (b), as well as all applicable State and Federal requirements for sustainable development. In those infrequent situations where LID is not appropriate given the characteristics of the site, the Navy and Marine Corps are authorized to establish a waiver process that, if used, would include regional engineer level review and approval.

The Navy and Marine Corps are directed to immediately plan, program, and budget to meet the requirements of this policy starting in FY 2011. All efforts shall be made to incorporate LID practices in the fiscal years 08, 09, and 2010. The services are further directed to submit to my office an annual report that summarizes all projects that have a storm water component and identify how LID was implemented or waived. If waived, the report must identify the approving official. Naval Facilities Engineering Command, as the Department's expert in acquisition, construction, and environmental management, shall assist Navy and Marine Corps installations in meeting these policies. My point of contact for this matter is CAPT Robin Brake, robin.brake@navy.mil, (703) 693-2931.

BJ Penn

[1] Major renovation projects are defined as having a storm water component and exceeding $5 million when initially approved by DASN (I&F). Major construction projects are defined as those exceeding $750K.

Low Impact Development Waiver Form

(Classification)

NAVY LOW IMPACT DEVELOPMENT WAIVER FORM	1. TODAY'S DATE	2. SUSPENSE DATE
3. PROJECT TITLE	3a. CONTRACT NUMBER	
	3b. MODIFICATION NUMBER	
4. DESIGN/CONSTRUCTION ORGANIZATION NAME(ES) AND ADDRESS(ES)	4a. NAME OF RESPONSIBLE PERSON/TITLE	
	4b. TELEPHONE NUMBER	
5. CONTRACT OFFICER NAME(ES) AND ADDRESS(ES)	5a. PROJECT NUMBER	
	5b. TASK NUMBER	
	5c. NAME OF RESPONSIBLE PERSON/TITLE OR RANK	
	5d. TELEPHONE NUMBER	
6. PROJECT DESCRIPTION		
6a. SUPPORTING DOCUMENTATION ☐ PLANS SUBMITTED ☐ STORM WATER CALCULATIONS SUBMITTED ☐ SUPPORTING DOCUMENTATION SUBMITTED		
7. WHY LID IS NOT PRACTICABLE FOR THIS PROJECT SITE		
7a. REASON NOT PRACTICABLE ☐ TECHNICAL ☐ ECONOMICAL ☐ OTHER		
8. PLANNED STORM WATER MANAGEMENT FEATURES (when LID is not practicable)		

9. SIGNATURES			COMMENTS
_____ _____ Project Manager (PM) Date	☐ APPROVED	☐ DISAPPROVED	
_____ _____ Design Manager (DM) Date	☐ APPROVED	☐ DISAPPROVED	
_____ _____ EV Department Eng (EDE) Date	☐ APPROVED	☐ DISAPPROVED	
_____ _____ FEAD/ROICC Date	☐ APPROVED	☐ DISAPPROVED	
_____ _____ Commanding Officer Date	☐ APPROVED	☐ DISAPPROVED	

WAIVER FORM INSTRUCTIONS

Parentheses at top of form: Fill in the classification (UNCLASSIFIED, CONFIDENTIAL, etc) in the parentheses at the top of the form.

Block 1. Enter today's date or due date of contract deadline. The Navy standard date format is YYYYMMDD. Example: 200070131.

Block 2. The format is YYMMDD. This suspense date should be completed by the Environmental Department Engineer (EDE) and/or Engineer In Charge (EIC). Enter the standard date the response is due to the contractor. (e.g. 30 days of receipt of contractors proposal) or Enter the date the response is due to the contractor if the review is time sensitive (e.g. 3, 10 days of receipt of contractor's proposal).

Block 3. Enter the Project Name and the LID technique or storm water Management feature.

Block 3a. Enter the contract number.

Block 3b. Enter the contract modification number.

Block 4. Enter the names and addresses of the engineering/design firm and the construction contractor.

Block 4a. - 4b. Enter the responsible performing organizations point of contact and position title (Lead Engineer, Manager, President, etc) and office phone number. This information is especially important to ensure any questions related to the project and site design can be quickly directed to the appropriate point of contact, avoiding delays in processing the action.

Block 5. Enter the Contract Agent Name and address.

Block 5a. Enter the project number.

Block 5b. Enter the task number (if applicable).

Block 5c -5d. Enter the responsible Contract Agent/Action officer's name, rank and/or position title, and office phone number. This information is especially important to ensure any questions related to the project and site design can be quickly directed to the appropriate point of contact, avoiding delays in processing the action.

Block 6. Provide a fact-filled background and summary of the project. Be sure to included details such as the project location, size, issues and the requirements. This discussion should tell the story of the planned project without "begging questions." The final approval authority should fully understand what the project is and why this project is necessary.

Block 6a. Select supporting documentation supporting the project. The site plans, storm water calculations and relevant supporting documentation for the selected LID design or the planned storm water management feature if LID is not selected, should be submitted along with the waiver form to ensure a thorough review.

Block 7. Explain which LID goals could not be achieved and why achieving LID goals was not practicable. Provide sufficient descriptions, drawings, and other necessary information to

confirm the applicability of the Waiver. The final approval authority should fully understand the reasons LID is not practicable for the project(s). Submit supporting documentation.

Block 7a. Select a reason LID is not practicable for this project, (e.g., conflicts with existing State laws, policies or requirements, contaminated sites).

Block 8. Describe the planned storm water management features if LID is not selected. Provide sufficient descriptions, drawings, and other necessary information to evaluate the proposed project. Submit supporting documentation.

Block 9. All parties must review, approve/disapprove, and sign the form for a LID waiver.

REVIEW AND CERTIFICATION
FOR
DOD MINIMUM ANTITERRORISM STANDARDS FOR BUILDINGS
CHECKLIST

*Instructions: The information outlined in this document shall be used to provide the **minimum** requirement for development of DOD Minimum Antiterrorism Standards for Buildings submittals for all building projects. Additional and supplemental information may be used to further develop the review. Insert N/A after criteria, which may be "not applicable". Provide this checklist with certification signatures in the project Design Analysis at each submittal.*

Applicable Standards: UFC 4-010-01

Chapter 1-2

Project Name: (Fill In Project Name)

Applicability: The DoD Minimum Antiterrorism Standards for Buildings apply to this project.

A. New Construction **This project consists of new construction.**

- Primary Gathering _____
- Billeting _____
- Inhabited _____
- Low Occupancy _____
- Expeditionary _____
- Temporary _____

B. Existing Building _____

Cost exceeds 50% of Replacement Cost _____
Cost less than 50% of Replacement Cost _____

- Primary Gathering _____
- Billeting _____
- Inhabited _____
- Low Occupancy _____
- Expeditionary _____
- Temporary _____

C. Building Addition _____

50% or more of the Gross Area _____
Less than 50% of the Gross Area _____

D. Leased Building _____

E. Expeditionary & Temporary Structures _____

- Has Appendix D requirements been incorporated? _____

F. National Guard Building _____

G. Tenant Bldgs. on DOD Installations _____

H. Exempt _____

Site Planning:

1. Standard 1 – Standoff Distance
   Appendix B-1.1 & Table B-1

   - Controlled Perimeter or Parking and Roadways w/o Controlled Perimeter
     - Primary Gathering – 148 Feet _____
     - Billeting – 148 Feet _____
     - Inhabited – 82 Feet _____

   - Parking and Roadways within a Controlled Perimeter
     - Primary Gathering – 82 Feet _____
     - Billeting – 82 Feet _____
     - Inhabited – 33 Feet _____

   - Trash Containers
     - Primary Gathering – 82 Feet _____
     - Billeting – 82 Feet _____
     - Inhabited – 33 Feet _____

   - Parking of Emergency, Command, and Operations Support Vehicles
     - Is parking of vehicles required? _____
     - Have the conditions for parking vehicles been met?

   - Parking of Vehicles Undergoing Maintenance
     - Is parking of vehicles required? _____
     - Have the conditions for parking vehicles been met? _____

   - New Parking and Roadway projects
     - Does new parking and road location meet minimum standoff distance requirements from existing buildings? _____

2. Standard 2 – Unobstructed Space
   Appendix B-1.2

   - Are there any obstructions within 33 Feet of the building that is 6 inches or greater in height? _____

- Are packages within the 33 foot distance observable by building occupants? _____

- Is Electrical and Mechanical Equipment 33 Feet or greater from the building? _____

- Equipment Enclosures:
  - Are walls or screening devices more than two sides? _____

  - If "yes" has a four sided enclosure w/ a top been provided? _____

3. Standard 3 – Drive-Up/Drop-Off Areas
   Appendix B-1.3

   - Are drive-up or drop-off areas, or drive-through lanes near building required? _____
     - If "yes" are the areas or lanes clearly defined and marked to to prevent parking in those areas? _____
     - Are drive-up or drop-off areas, or drive-through lanes not located under inhabited portion of bldg? _____

4. Standard 4 – Access Roads
   Appendix B-1.4

   - Have access control measures been provided on access roads required for the operation of the building? _____

5. Standard 5 – Parking Beneath Buildings or on Rooftops
   Appendix B-1.5 & UFC 4-023-03

   - Is parking beneath the building or on roof top required? _____
     - If "yes" has access control Measures been provided? _____
     - Are floors beneath or roofs above inhabited areas designed to prevent progressive collapse? _____

6. Appendix C – Recommended Additional Measures
   Appendix C-1.1 thru C-1.10

   - Has recommendations 1 thru 10 been considered?
     - 1 – Vehicle Access Points? _____
     - 2 – High-speed Vehicle Approaches? _____
     - 3 – Vantage Points? _____
     - 4 – Drive-up / Drop Off? _____

- 5 – Building Location? _____
- 6 – Railroad Location? _____
- 7 – Access Control for Family Housing? _____
- 8 – Standoff for Family Housing? _____
- 9 – Minimize Secondary Debris? _____
- 10 – Building Separation? _____

Structural:

7. Standard 6 – Progressive Collapse Avoidance
   Appendix B-2.1 & UFC 4-023-03

   - Is building 3 or more stories? _____
     (NOTE: Basements are considered a story if one or more walls are exposed.)

   - If "yes" are walls, columns, and floors in accordance with UFC 4-023-03, Design of Buildings to Resist Progressive Collapse? _____

8. Standard 7 – Structural Isolation
   Appendix B-2.2

   - Is new building addition structural system independent from the adjacent adjacent existing building? _____

   - Is inhabited portion of new building structurally independent from the uninhabited portion of the building? _____

9. Standard 8 – Building Overhangs
   Appendix B-2.3

   - Does building have overhangs with inhabited spaces above them? _____
     - If "yes" insure that there are no roadways or parking areas under the overhangs.
     - If "yes" insure that floors beneath inhabited areas are in accordance with UFC 4-023-03, Design of Buildings to Resist Progressive Collapse.
     - If "yes" insure that superstructure is in accordance with UFC 4-023-03, Design of Buildings to Resist Progressive Collapse.

10. Standard 9 – Exterior Masonry Walls
    Appendix B-2.4

    - Is masonry wall in new building reinforced

with required minimum enforcement? _____
- Has mitigating measures been provided for masonry wall in existing building that provides an equivalent level of protection? _____

11. Appendix C – Recommended Additional Measures
Appendix C-2.1

- Has recommendation 11 been considered?
- 11 – Structural Redundanct? _____

12. Other Structural Requirements

- Has structural requirements related to windows been considered? (See Architectural Standard 10)
  - Yes _____
  - No _____

Architectural:

13. Standard 10 – Windows and Skylights
Appendix B-3.1 & UFC 4-011-02

- Has required thickness of exterior glazing be determined using Tables B-2 & B-3? _____

- Do window frames, anchorages, and supporting elements meet required minimum level of protection for the following? _____
  - Frame Member Design
  - Glazing Frame Bite
  - Frame Connection to Wall
  - Supporting Structural Elements

14. Standard 11 – Building Entrance Layout
Appendix B-3.2

- Does building main entrance face away from the installation perimeter or other uncontrolled vantage point? _____
  - If “no” provide means to screen Lines of site.

15. Standard 12 – Exterior Doors
Appendix B-3.3

- Do all exterior doors from inhabited areas open outwards? _____

- Does glazing in doors meet Provisions of Standard 10 above? _____

16. Standard 13 – Mailrooms
Appendix B-3.4 & B-4.2

- Is mailroom located on the exterior perimeter of the building? _____
- Is mailroom located as far away from heavily populated areas as possible? _____
- Is mailroom sealed between its envelope and other portions of the building in which it is located? _____
    - Does mailroom have a hard ceiling or does mailroom walls extend full height and are sealed to underside of structure above? _____
    - Does mailroom door have weather stripping on all four edges? _____

17. Standard 14 – Roof Access
Appendix B-3.5

- Are external roof access points controlled? _____

18. Standard 15 – Overhead Mounted Architectural Features
Appendix B-3.6

- Are overhead mounted features weighing 31 lbs. or more mounted to minimize falling and injuring building occupants? _____
- Are these items mounted to resist forces of 0.5 times the component weight in any direction and 1.5 times the component weight in the downward direction? _____

19. Appendix C – Recommended Additional Measures
Appendix C-2.2 thru C-2.7

- Has recommendations 12 thru 17 been considered?
    - 12 – Internal Circulation? _____
    - 13 – Visitor Control? _____
    - 14 – Asset Location? _____
    - 15 – Room Layout? _____
    - 16 – External Hallways? _____
    - 17 – Windows? _____

Mechanical and Electrical:

20. Standard 16 – Air Intakes
Appendix B-4.1

- Are all air intakes a minimum of 10 feet above the ground? _____

21. Standard 17 – Mailroom Ventilation
Appendix B-4.2 & DOD Security Engineering Design Manual

- Does mailroom have separate dedicated air ventilation system? _____
- Is dedicated exhaust system to maintain slight negative air pressure provided? _____
- Has outside air intakes and exhausts With low leakage isolation dampers been provided? _____
- Has separate switches or methods of control to isolate mailroom been provided? _____

22. Standard 18 – Emergency Air Distribution Shutoff
Appendix B-4.3

- Has Emergency shutoff switch in HVAC control system been provided? _____
- Is switch(es) easily accessible to building occupants? _____

23. Standard 19 – Utility Distribution and Installation
Appendix B-4.4

- Are critical or fragile utilities routed so they are not located on exterior walls or on walls shared with mailrooms? _____
- If redundant utilities are required are they routed so they are not collocated or are not run in same chases? _____
- If emergency backup systems are required are they located away from the system components for which they provide backup? _____

24. Standard 20 – Equipment Bracing
Appendix B-4.5

- Are overhead mounted features weighing 31 lbs. or more located to minimize falling and injuring building occupants? _____

- Are these items mounted to resist forces of 0.5 times the component weight in any direction and 1.5 times the component weight in the downward direction? _____

25. Standard 21 – Under Building Access
Appendix B-4.6

- Are accesses to crawl spaces, utility tunnels, and other means of under building access controlled? _____

26. Standard 22 – Mass Notification
Appendix B-4.7 & UFC 4-021-01

- Has a mass notification system been provided in the new building? _____

  If required the design must comply with Standard 22. The MNS must integrate with existing Base MNS. Point of Contact: Provost Marshal Office, Physical Security Section, Mr. Zack parks at (910) 451-5810.

- Has a mass notification system been provided in existing primary gathering, billeting, and high occupancy family housing buildings? _____

  If required the design must comply with Standard 22. The MNS must integrate with existing Base MNS. Point of Contact: Provost Marshal Office, Physical Security Section, Mr. Zack parks at (910) 451-5810.

Certification of Force Protection Requirements
Preparers of this document certify the accuracy and completeness of the Antiterrorism Force Protection features for this project in accordance with the attached completed form(s).

This Review and Certification for DoD Minimum Antiterrorism Standards for Buildings Checklist was completed on the following date:

INTERIM or PRELIMINARY DESIGN

(Fill In Project Name)

Architect-Engineer
Certification of Antiterrorism Standards
(Note: Edit the team members if necessary)

Preparers of this document certify the accuracy and completeness of the Antiterrorism Force Protection features of this project.

Civil Engineer of Record:

_____

Signature Date

Architect of Record:

_____

Signature Date

Structural Engineer of Record:

_____

Signature Date

Mechanical Engineer of Record:

_____

Signature Date

Electrical Engineer of Record:

_____

Signature Date

CAMP LEJEUNE, NORTH CAROLINA

ANTITERRORISM STANDARDS REVIEW

for

(Fill in Project Name)

INTERIM or PRELIMINARY DESIGN

Review and Certification for Minimum Antiterrorism Standards for Buildings Checklist has been completed and is attached. The Antiterrorism Force Protection review, and related design analysis documentation have been checked and approved by the in-house design team.

Project Design Team Leader Signature _____ Date _____

Antiterrorism Force Protection Team:

Civil Team Member Signature _____ Date _____

Architectural Team Member Signature _____ Date _____

Structural Team Member Signature _____ Date _____

Mechanical Team Member Signature _____ Date _____

Electrical Team Member Signature _____ Date _____

CAMP LEJEUNE, NORTH CAROLINA

ANTITERRORISM STANDARDS REVIEW

for

(Fill in Project Name)

FINAL DESIGN

The project specific **Review and Certification for Minimum Antiterrorism Standards for Buildings Checklist** has been completed and is attached. The construction contract plans, specifications, and related design analysis documentation have been checked and approved for accuracy and coordination.

Project Design Team Leader Signature _____ Date _____

Camp Lejeune Antiterrorism Officer Signature: _____ Date _____

NAVFAC ELEVATOR DESIGN GUIDE

FINAL DRAFT

08/10/2011

Enclosure (1)

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CHAPTER 1

INTRODUCTION

1-1 Purpose. Elevator installations are complex, multi-disciplined systems that interface with many aspects of the facility design. Design considerations require coordination with architectural, structural, mechanical, electrical, and fire protection disciplines. This document was developed to assist and direct architects, engineers, and project managers in the development of project request for proposal(RFP), design, and specification documents related to the procurement of elevator systems in Navy Facilities.

NFPA 101, Life Safety Code, mandates compliance with ASME A17.1, Safety Code for Elevators and Escalators, International Building Code, IBC, and other non-governmental safety standards. These standards identify minimum design and performance requirements for elevator systems and for building systems that interface with the elevator installation. The performance language used in the codes and standards results in many different, and often conflicting, interpretations by the hundreds of federal, state, and municipality "Authorities Having Jurisdiction" (AHJ) across the country and around the world.

NAVFAC is the AHJ for VTE in Navy and Marine Corps Facilities. The NAVFAC Elevator Subject Matter Expert (SME) manages the NAVFAC VTE Program and provides interpretation and direction for the application of safety codes and standards as they apply to VTE in Navy and Maine Corps facilities.

NAVFAC Elevator Design Criteria provides specific direction for the application of the non-government standards that apply to elevators and other types of VTE. The criteria provides consistent and uniform methods to be used to comply with the performance language of the applicable building and safety codes. In addition, NAVFAC Design Criteria specifies quality and performance requirements, for specific elevator components and systems, to ensure sustainability, effective performance, optimum life-cycle costs, and energy efficiency.

1-2 Scope. This document provides NAVFAC Elevator Design Criteria that applies to all elevators, and other types of VTE, in Navy and Marine Corps facilities.

1-3 References. References are provided in Appendix A. The listing is not exclusive; the elevator design and installation must comply with this ITG and all applicable reference documents and building and safety codes. The elevator and facility design must comply with the edition in effect at the time of contract award.

1-4 Content and Format. This document is arranged by design disciplines. Within each chapter, the content is arranged by major elevator systems and components.

CHAPTER 2
PROJECT DEVELOPMENT

2-1 Criteria Documents

The project development process shall determine the need for elevators through compliance with the most stringent requirements of the following criteria:

a. The new DoD "ABA (Architectural Barriers Act) Accessibility Standard" (DoD ABAAS) and the DEPSECDEF Memorandum

b. NAVFAC Facility Design Criteria for the facility type under design

c. NAVFAC Facility Design Program requirements for each specific project

2-2 Client Survey and Traffic Study

To determine the elevator types, service, and quantity necessary for effective elevator service, the design process must include a client survey and a traffic study of the proposed facility design. The two basic elevator types are hydraulic elevators and electric traction elevators. The two categories of service that are recognized by ASME A17.1 are Passenger and Freight.

2-2.1 Client Survey and Traffic Study Factors

The client survey and traffic study are also conducted to determine requirements for elevator capacities, speeds, and elevator cab interior dimensions. For unique facilities and for facilities

with critical demand requirements, the traffic study must be performed by a qualified elevator consultant. The following factors must be utilized in the analysis:

(1) Type and Use of Building
(2) Size and Height of Building
(3) Building Population
(4) Exterior Traffic Considerations
(5) Anticipated Traffic Flow
(6) National Elevator Industry, Inc. “Vertical Transportation Standards”
(7) LEED Certification Design Considerations

2-2.2 Passenger or Freight Classification

The designer and client must decide whether a passenger elevator or freight elevator is most appropriate for each elevator in the facility. This decision will be based on anticipated usage of each elevator. If the elevator will be used for the movement of personnel, it must be designed as a passenger elevator. Any elevator that is a component of a handicapped accessibility route must be designed as a passenger elevator. If the elevator will be used strictly for the movement of materials, it may be classified and designed as a freight elevator.

2-2.2.1 ASME A17.1 allows a freight elevator to have a greater platform area than a passenger elevator, given the same load rating. Because of this, if an elevator is designed and installed as a freight elevator, that decision cannot be reversed at a later date and the elevator may never be utilized for passenger use. This classification severely limits the flexibility of use that is provided by the passenger elevator classification. .

2-2.3 Handicapped Accessibility

All passenger elevators must be designed to accommodate handicapped accessibility.

2-2.4 Emergency Medical Services Accessibility

For all buildings, a minimum of one passenger elevator must be designed to accommodate emergency medical services access to all floors of the building. The elevator shall be of such a size and arrangement to accommodate a 24-inch by 84-inch (610mm by 1930mm) ambulance stretcher in the horizontal, open position and shall be identified by the international symbol for emergency medical services (star of life). If the facility is equipped with emergency power, this elevator must be powered by the emergency power system.

2-2.5 Elevator Operational Features

The client survey must include choices for elevator operational features, including:

a. Emergency Commandeering Service

b. Security and Access Control Systems

2-2.6 LEED Certification Design Options

a. High-Efficiency Gearless Machine

A high-efficiency gearless machine has been developed and incorporated into elevator design within the elevator industry. This type is similar to traditional gearless traction machines. However, the high-efficiency gearless machine utilizes an electric motor design that uses permanent magnets to increase the energy efficiency of the drive machine. This type of elevator should be considered for all facilities.

b. "Regenertive Drive" Motor Control

"Regenertive Drive" motor control systems have been developed for electric traction elevators and are incorporated into elevator design within the elevator industry. This motor control system uses the energy that is developed when the elevator is running in an overhauling load condition. The drive converts the mechanical energy into electrical energy and feeds it back to the facility power grid. This control system should be considered for all facilities with electric traction elevators.

2-3 Building Supporting Systems

There are multiple building systems that interface with the elevator design and control system. The interface design is determined by the requirements of the International Building Code and numerous safety codes and standards.

2-3.1 Building Fire Alarm Panel

All elevators must be equipped with Firefighters' Emergency Operation. The system provides an automatic elevator operational response to fire detection devices in the elevator machine room (MR), elevator lobbies, and sometimes in the elevator hoistway. Design of the fire protection system is identified in the NAVFAC Fire Protection UFC.

2-3.2 Emergency Power

The Designer of Record must determine if the client requires elevator operation under emergency power. The design of the elevator emergency power operation must address the following:

(1) How many and which elevators will run simultaneously.
(2) Location of elevator MRs and possible control wiring interconnections for sequential elevator operation.
(3) Design of the electrical control circuit from the Automatic Transfer Switch (ATS) to the elevator controller.
(4) Ensure all elevator mainline disconnects are fed from the emergency power buss.

2-3.2.1 Elevators that are not designed for emergency power operation must be designed and equipped with an emergency battery lowering system that will run the elevator to the next available landing, open the doors, and shut the elevator off at that landing.

2-3.3 Building Telephone and Communication Systems

Emergency communication is required from the elevator cab to an emergency response desk that is manned 24 hours a day. The emergency response communication system must be answered by emergency personnel and not by an automated answering system. In addition, the elevator cab communication device must provide communication between the elevator MR and the elevator cab.

2-4 Contract Options and Documentation

2-4.1 Contract Type

Contract types for new construction projects typically include either Design-Build or Design-Bid-Build.

2-4.1.1 For Design Build Contracts, the design team develops a Request for Proposal (RFP), using the Design-Build Template that is located on the Whole Building Design Guide.

2-4.1.2 For Design-Bid-Build Contracts, the design team develops full plans and specifications for the project. Plans and specifications will be developed either in-house or through contract with an A/E firm.

2-4.2 Uniform Facilities Guide Specifications

For all contracts, utilize the complete and most current version of the Naval Facilities Guide Specifications (NFGS) for elevators to specify the project elevators. The NFGS are available on the Whole Building Design Guide. Any editing of non-bracketed paragraphs within the specification must be specifically approved by the responsible NAVFAC Elevator Program FEC LCO.

2-4.3 Design Coordination and Support

Coordinate project RFP elevator requirements with the NAVFAC FEC VTE Lead Certifying Official. A contact listing of NAVFAC VTE Program Managers and Lead Certifying Officials is provided as Appendix B.

2-4.4 NAVFAC VTE Program Design Comments or Questions

For elevator design questions and comments, contact the NAVFAC Elevator Program Manager, Deputy Program Manager, or the NAVFAC FEC Lead Certifying Official for your geographic area.

2-5 Application of Elevator Types to Facility Design

This section identifies and describes the types of elevators that may be installed in Navy Facilities and the application of each type to the size and function of the facility. This section also identifies speed and travel requirements for each type and application.

2-5.1 Hydraulic Elevators

Hydraulic elevators may be used for low-rise facilities of 2 to 4 stories. Direct plunger hydraulic elevator design must be used for hydraulic elevators in Navy Facilities.

EXCEPTION: In the event of compelling design conditions, approval for use of a roped-hydraulic elevator design may be requested, on an individual project, by submission of a written Request for Approval to the NAVFAC VTE Program FEC Lead Certifying Official.

Telescopic plungers and inverted cylinder/plunger assemblies must not be installed in Navy Facilities.

2-5.1.1 There are three main types of hydraulic elevators:

(1) In-ground Direct Plunger: An elevator cylinder and plunger assembly is installed in the ground, below the elevator cab. The elevator cab frame is connected to the top of the plunger and moves up as hydraulic fluid is pumped into the cylinder from a reservoir. For a travel distance of 15’ or less, the rated speed shall be 125 fpm. For a travel distance between 15’ and 44’, the rated speed shall be 150 fpm. Do not exceed a maximum travel length of 44’ (13411 mm) or a maximum building height of four floors for this type of elevator.

(2) Hole-less: Either one or two hydraulic cylinder/plunger assemblies are installed vertically, in the elevator hoistway, with the bottom of the cylinder supported by the hoistway pit floor. The cab frame is attached to the top of the plunger and moves up as hydraulic fluid is pumped into the cylinder from a reservoir. The rated speed shall be 125 feet per minute for this type of elevator. Travel is limited by pit depth and hoistway overhead.

(3) Roped: This type shall not be used for new construction of Navy Facilities.
NOTE: Roped-hydraulic elevators may be considered for modernization of existing facilities, subject to the approval of the NAVFAC VTE Program Manager. Request for design approval shall be submitted to the NAVFAC FEC VTE LCO.

EXCEPTION: In the event of compelling design conditions, the use of a roped-hydraulic elevator may be appropriate. Approval for use of a roped-hydraulic elevator design may be requested, on an individual project, by submission of a written Request for Approval to the NAVFAC VTE Program FEC Lead Certifying Official (LCO). The LCO is authorized to grant an exception to this restriction.

The roped design is similar to the standard hole-less elevator design. The difference is that a wire rope sheave is mounted to the top of the hydraulic plunger and steel hoist ropes are attached to the cylinder base, run over the sheave, and down to the cab frame. As the cylinder runs up, the 1:2 roping moves the elevator cab twice the distance of the plunger travel. Car speed is 150 feet per minute and maximum travel length is 48 feet (14630 mm). The cost of acquisition, maintenance, and service for a roped-hydraulic elevator is substantially greater than for the direct plunger types.

2-5.2 Electric Traction Elevators

Electric Traction Elevators may be used for all facilities. There are two types of electric traction hoist machines, geared and gearless. In addition, there is a smaller, more efficient gearless elevator machine design that is relatively new to the elevator industry. The building height and travel of the elevator will determine the most effective application of each type.

2-5.2.1 The basic design is similar for each of the types of elevator drive machines. Steel hoist ropes (wire ropes) are suspended in the elevator hoistway and supported by the elevator drive machine. The elevator cab is fastened to one end of the hoist ropes and the elevator counterweight is fastened to the other end of the hoist ropes. The counterweight is used to counterbalance the weight of the elevator cab. Minimum car speed requirements are identified for each type of electric traction elevator machine.

(1) Geared Traction Machine: The elevator drive motor and geared machine are located in the elevator machine room. The motor drives a worm and ring gear assembly in the elevator drive machine. The ring gear turns the drive sheave which runs the elevator cab up and down in the hoistway . This type of electric traction elevator may be used for mid-rise applications of 4 to 10 floors. Car speed must be a minimum of 350 feet per minute.

(2) Gearless Traction Machine: The elevator gearless drive machine is located in the elevator machine room. The motor connects directly to the drive sheave; there is no gear reduction unit. This type of electric traction elevator may be used for mid-rise applications and must be used for high-rise applications of greater than 10 floors. Car speed must be a minimum of 350 fpm for mid-rise and 500 fpm for high-rise applications.

(3) High Efficiency Gearless Machine: This type is very similar to the gearless traction machine above. However, the high efficiency gearless machine utilizes an electric motor design that incorporates permanent magnets to increase the energy efficiency of the drive machine. The machine is located in the elevator machine room. This type may be used for low-rise to high-rise applications. Car speed must be a minimum of 350 fpm for mid-rise and 500 fpm for high-rise applications.

CHAPTER 3

ARCHITECTURAL

Design and installation of elevator system must be in accordance with this ITG and all applicable reference documents and building and safety codes. A listing of reference documents is provided as Attachment A. The elevator design must comply with the edition in effect at the time of contract award.

3-1 Elevator Machine Room

An elevator machine room must be provided for every elevator. The elevator machine and elevator controller must be located in the elevator machine room.

3-1.1 Elevator Machine Room Location

The elevator machine room (MR) must be located directly adjacent to the elevator hoistway. For facilities that are not located in a flood zone, locate hydraulic elevator MR on the lowest landing served by the elevator.

3-1.1.1 For facilities located in a flood zone, locate MR on the next highest floor level that is above flood zone elevations, as determined by ASCE 24-05, Flood Resistant Design and Construction.

3-1.2 Elevator Machine Room Plans

Develop detailed plans and sections for elevator machine room. Show roof top machine room on elevations and plans for electric traction elevators. Provide all layout drawing information required by ASME A17.1. Include the following:

a. Locate MR and hoistway on the same side of any building expansion joint.
b. Provide 2-hour fire resistant construction for all elevator machine rooms. MR enclosure may not contain access panels in the walls or ceiling.
c. MR fire rated ceiling must not exceed 12’ (3658 mm) in height .
d. Machine room door must have a minimum fire rating of 1 ½ hour .
e. Louvers and undercuts of machine room door are not permitted.
f. Design all machine beam support with hoistway wall beam-pocket construction.

3-1.2.1 Elevator MR door must include the following:

a. MR door must be equipped with panic hardware for MR exit and with key operated hardware from outside only. A lever type handle on the MR side of the door shall be provided if the building hallway design precludes the use of an swing-out door.
b. MR door must be self-closing and self-locking.

3-1.2.2 Mechanical equipment and systems must conform to the following:

a. Provide an unobstructed 7'-0" (2133 mm) minimum vertical clearance (headroom) below all solid items in the elevator machine room. The 7' headroom applies to all building components and all installed mechanical or electrical system components.

b Only items that are directly related to the installation and operation of the elevator may be installed in the elevator machine room. In addition, pipes, ducts and conduit not related to the elevator system must not penetrate the machine room.

3-1.3 Elevator Machine Room Access

A clear access route must be provided from the facility exterior entrance to the elevator MR door. The route must have a minimum width of 36" and a minimum height of 84".

3-1.3.1 A stairway with a maximum inclination of 45 degrees must be provided for vertical access to an

elevator MR. Vertical ladders, ships ladders, and alternating step tread designs must not be used for MR access. Steps must be designed with a maximum riser height of 8" and a minimum step tread depth of 8", as measured from each adjoining step, nose to nose. The height of the access stairs may not exceed a rise of 10' without an intermediate landing.

3-1.4 Elevator Machine Room Floor Differences

For any difference in the height of the machine room floor, provide a standard railing on the upper floor level

3-2 Elevator Hoistway

3-2.1 Elevator Hoistway Pit Entrapment Protection

The design of the elevator and hoistway must provide a minimum horizontal clearance of 20" between the side of the elevator platform/cab and any one wall of the elevator hoistway. A horizontal clearance of 20" Deep X 30" Wide must be maintained from the pit floor to the top of the hoistway entrance assembly at the lowest landing.

3-2.2 Elevator Hoistway Plans

Develop detailed plan and section drawings for elevator hoistway. Show location of all support beams in the hoistway. For multiple elevators in the same hoistway, provide divider beams for guide rail support brackets. Provide all layout drawing information required by ASME A17.1. Include the following:

a. Provide 2-hour fire resistant hoistway construction. Hoistway enclosure may not contain any access panels or doors in the walls or ceiling, except as necessary for the operation, maintenance, and service of the elevator.
b. Hoistway entrance assemblies must have a minimum fire rating of 1 ½ hour.
c. All hoistway door frames must be filled with grout to a height of 5'.
d. Hoistway enclosure must be plumb and have flush surfaces on the hoistway side.
e. Provide a lifting beam at the top of the hoistway for installation of elevator equipment.
f. Design all machine beam support with hoistway wall beam-pocket construction.

g. Hoistway ventilation must be provided in accordance with IBC Chapter 30.

3-2.2.1 Only mechanical equipment and systems that are directly related to the installation and operation of the elevator may be installed in the elevator hoistway. In addition, pipes, ducts, and conduit not related to the elevator system must not penetrate the hoistway.

3-3 Elevator Hoistway Pit

3-3.1 Elevator Hoistway Pit Ladder

A hoistway pit ladder must be provided for all pits with a depth of Detail pit ladder on the detail drawings of the elevator pit. Include the following:

a. Provide a minimum clearance of 4.5" between ladder and the hoistway wall.
b. Ladder must extend a minimum of 4' above the hoistway entrance sill.
c. Provide continuous, non-slip, horizontal rungs for the full height of the pit ladder.
d. Locate ladder within 39 horizontal inches of the hoistway door unlocking device.

3-3.2 Elevator Hoistway Pit Sump and Sump Pump

All elevator hoistways must be equipped with a sump pit, sump pump, and permanent discharge piping to a point outside of the elevator hoistway and MR. Comply with the following:

a. Minimum sump pump discharge must be 50 gallons per minute, per elevator. Sump pump and piping must be sized to accomplish this output, regardless of head pressure or piping run.
b. Design hoistway sump pit large enough to fully enclose submersible sump pump and control sensors below hoistway pit floor level.
c. Discharge to an approved location that can accommodate a full, continuous pump output and does comply with all applicable discharge permits, regulations, and statutes.
d. Provide fully supported, removable grate cover with top of grate flush with pit floor.
e. Coordinate power requirements with Electrical engineer.

3-3.2.1 In addition to the requirements of 3-3.2, hydraulic elevator installations must be designed with a sump pump oil sensing
control system to allow water to be pumped out of the sump without pumping oil/hydraulic fluid from the elevator hoistway pit. The sump pump control system must include an audible alarm and visual indicators for water and oil. The alarm indicators and controls must be installed in the elevator machine room.

3-3.3 Elevator Hoistway Pit Fall Protection

For pit depths of 6' or greater, a fall protection system must be designed and installed adjacent
to the hoistway pit ladder, for personnel access into the hoistway pit.

CHAPTER 4

STRUCTURAL

Structural design must be in accordance with this ITG and all applicable reference documents and building and safety codes. A listing of reference documents is provided as Attachment A. The elevator design must comply with the edition in effect at the time of contract award.

4-1 Elevator Machine Room

4-1.1 Locate the elevator hoistway and elevator machine room on the same side of all building expansion joints.

4-2 Elevator Hoistway

4-2.1 In all seismicity regions, ensure adequate structural support for the attachment of the elements of the elevator support system as required by the elevator manufacturer's design, applicable codes, and UFC 3-310-04.

4-2.2 Clay tile or brick shall not be used in the construction of hoistway walls. Hollow block, if used, must be filled solid with concrete or motar.

4-3 Elevator hoistway Pit

4-3.1 Hoistway drawings must indicate water stops in the walls and waterproofing for elevator pit floor and walls, if these items are not shown on architectural drawings.

4-3.2 Hoistway pit structure must be designed for all static and reaction loads that it will be subjected to by the elevator system. Indicate details for sump pump pit and the impact of the sump pit on the foundation for the structure.

CHAPTER 5

MECHANICAL

Design and installation of mechanical systems must be in accordance with this ITG and all applicable reference documents and building and safety codes. A listing of reference documents is provided as Attachment A. The elevator design must comply with the edition in effect at the time of contract award.

5-1 Elevator Machine Room

5-1.1 Elevator MR Temperature and Humidity Control

An HVAC heating and cooling system must be designed and provided for every elevator MR, to maintain MR temperature between 50 and 90 degrees F (10 to 32 degrees C) and relative humidity between 35% and 60% at all times and in all weather conditions. HVAC system design mustaccommodate the BTU output of the elevator equipment.

5-1.1.1 Air conditioning and heating capabilities are required in most conditions; gravity ventilation is not acceptable. Elevator controller cabinet AC units must not be used for conditioning. Coordinate with Electrical Design requirements.

5-1.1.2 HVAC conditioning equipment must not be located above elevator equipment. AC condensate lines must drain to a location outside of the elevator MR and hoistway.

5-1.2 Mechanical Equipment Installation

Mechanical equipment and systems must conform to the following:

a. Provide an unobstructed 7'-0" (2133 mm) minimum vertical clearance (headroom) below all solid items in the elevator machine room. The 7' headroom applies to all building components and all installed mechanical or electrical system components.

b Only items that are directly related to the installation and operation of the elevator may be installed in the elevator machine room. In addition, pipes, ducts and conduit not related to the elevator system must not penetrate the machine room.

5-1.3 Machine Room Sound Level

The acoustic output of any equipment in elevator machine room must not exceed 80 dBA, measured at any point in the elevator machine room.

5-2 Elevator Hoistway

5-2.1 Elevator Hoistway Ventilation

Provide exterior ventilation of hoistway in accordance with IBC. If ventilation is required, provide a weatherproof louver with a minimum free area of 3 1/2% of the area of the hoistway pit but in no case can it be less than a free area of 3 square feet. The hoistway wall

penetration must comply with the ASME A17.1 elevator safety code recess and setback requirements.

5-2.1.1 For geographic locations with exterior conditions that are detrimental to the elevator hoistway equipment and to building conditions, an automatic louver may be provided. The automatic louver must be equipped with a mechanical spring device to apply opening pressure at all times. The safety code allows the louver to be held in the closed position as long as it is monitored and controlled by the facility fire alarm panel.

5-2.2 Mechanical Equipment Installation

Only mechanical equipment and systems that are directly related to the installation and operation of the elevator may be installed in the elevator hoistway. In addition, pipes, ducts and conduit not related to the elevator system must not penetrate the hoistway.

5-3 Elevator Hoistway Pit

5-3.1 Elevator Hoistway Pit Sump and Sump Pump

For all elevators, a sump pit and an automatic sump pump system must be provided. Permanent discharge piping must be provided to a point outside of the elevator hoistway and MR. Comply with the following:

a. Minimum sump pump discharge must be 50 gallons per minute, per elevator. Sump pump and piping must be sized to accomplish this output, regardless of head pressure or piping run.
b. Provide fully supported, removable grate cover with top of grate flush with pit floor.
c. Discharge to an approved location that will accommodate full pump output and comply with all applicable discharge permits, regulations, and statutes.
d. Coordinate sump pump size with Architect to ensure that the sump pump and control sensors will fit completely within the sump.
e. Coordinate power requirements with Electrical engineer.

5-3.1.1 In addition to the requirements of 5-3.1, hydraulic elevator installations must be designed with a sump pump oil sensing control system to allow water to be pumped out of the sump without pumping oil/hydraulic fluid from the elevator hoistway pit. The sump pump control system must include an audible alarm and visual indicators for water and oil. The alarm indicators and controls must be installed in the elevator machine room.

5-3.2 Elevator Hoistway Pit Sprinkler Protection

In buildings protected with an automatic sprinkler system, provide sprinkler in the pit for hydraulic elevators (except in Italy). Locate sprinkler head no more than 2’-0” (609 mm) above the pit floor.

CHAPTER 6

ELECTRICAL

Design and installation of all electrical wiring and equipment must be in accordance with this ITG and all applicable reference documents and building and safety codes. A listing of reference documents is provided as Attachment A. The elevator design must comply with the edition in effect at the time of contract award.

6-1 Elevator Machine Room

6-1.1 Elevator Power Supply

For each elevator, a separate electrical power service must be provided from the main building electrical distribution panel to the elevator machine room. The electrical service must comply with the following:

a. The elevator electrical service must include a fourth-wire dedicate earth ground.
b. The electrical power supply must provide a balanced 3-phase power supply with a maximum voltage variation of 5 % between any two phases.
c. Designer must consider type of elevator drive specified, i.e., SCR, VVVF, etc., and design service accordingly.

6-1.2 Elevator Disconnecting Means

Locate the elevator disconnecting means on the wall inside the MR, on the strike jam side of the MR door, within sight of the elevator equipment it controls. The disconnecting means must be numbered to correspond to the identifying number of the driving machine that it controls.

6-1.2.1 Ensure that each elevator disconnecting means has the following signs permanently attached:

a. Permanent sign to identify the location of the supply side overcurrent protective device.
b. WARNING
PARTS OF THE CONTROLLER ARE NOT DE-ENERGIZED BY THIS SWITCH

6-1.2.2 For all elevators with fire protection sprinklers in the elevator MR or top of hoistway, provide a shunt trip circuit breaker in the elevator MR for each individual elevator main power, and emergency power if provided. Circuit breaker must be capable of being locked in the open position only.

Each shunt trip circuit breaker must be served by a dedicated breaker in the main distribution electrical panel. Shunt trip breaker(s) must be designed to be operated both manually and by actuation of the sprinkler flow switch(s) designed to automatically open the power supply to the elevator. Power must be restored manually.

6-1.2.3 A sprinkler line flow switch must be provided, according to the design requirements of Chapter 7, Fire Protection. The flow switch must be equipped with an electrical circuit that will actuate the elevator main-line shunt trip disconnect. The sprinkler line flow switch

control circuit must be monitored for the presence of operation voltage. Loss of voltage shall cause actuation of a supervisory signal and alarm at the building fire protection panel.

6-1.3 MR 120 VAC Lighting and Receptacle Circuit

A separate 120 VAC branch circuit must be provided for the elevator MR lighting and receptacles. The

MR lighting shall not be equipped with automatic controls or be fed from the load side of a GFCI circuit.

6-1.3.1 A minimum of two 2-light, 1.2 m (4 ft) long fluorescent lighting fixtures must be provided for

lighting of the elevator MR. The fixture must have a one piece, molded, high-impact clear acrylic diffuser with a secure seal against dust and moisture. MR lighting must provide a minimum of 19 fc at floor level, in all areas of the MR.

6-1.4 Separate branch Circuits

For each of the following circuits, provide a separate, dedicated branch circuit with a fused disconnect or breaker in the elevator MR. Individual disconnects and breakers must be designed to be lockable in the open position only.

a. Elevator 120 VAC circuit for elevator cab lighting and receptacles.
b. Elevator cab HVAC equipment circuit, if provided.
c. Elevator hoistway pit sump pump power and control system.

6-1.4.1 For all MR disconnects, provide a permanent sign, on each disconnect, to identify the location of the supply side overcurrent protective device.

6-1.5 Emergency Power

If emergency power is provided, comply with the requirements of Section 6-1 and the following:

a. The MR disconnecting means must disconnect both normal and emergency power.
b. Emergency power system must be designed to operate selected elevator(s) at rated speed with rated load.
c. System design must accommodate automatic sequential operation to bring all elevators to the designated floor and provide selected elevator(s) with emergency power operation. Control wiring may be required between MRs for sequential operation.
d. Provide manual selector switch in main elevator lobby area(s) to allow emergency personnel to override the automatic emergency power selection.
e. Provide emergency power for MR lighting and MR HVAC equipment.
f. Provide emergency power for Cab lighting and Cab HVAC equipment.
g. Provide emergency power for hoistway pit sump pump operation.

6-1.6 Emergency Communication Systems

Provide telephone outlet with dedicated line next to each elevator controller for emergency phone service in elevator car. Indicate outlets on telephone riser.

6-1.6.1 Provide emergency communication between the elevator cab and the elevator MR for all elevators with a travel of 60' or greater and for all elevators with a remote MR (when MR and hoistway do not share a contiguous wall).

6-1.7 Firefighters' Emergency Operation

The design of the building fire detection and alarm system must include an effective interface with the elevator controller for actuation of Fire Fighter's Emergency Operation (FEO), in accordance with ASME A17.1.

6-1.7.1 For FEO actuation, provide ceiling mounted smoke detectors in elevator lobbies, elevator MR, and sometimes in the elevator hoistway, in conformance with the NAVFAC Fire Protection UFC. Indicate smoke detectors on electrical drawings unless there are separate fire protection drawings. Coordinate with Fire Protection Engineer.

6-1.7.2 For a code compliant interface with the elevator controller, the smoke detector/fire alarm initiating device system will require 3 to 4 relay modules for actuation of the elevator Firefighters' Emergency Operation. Mount FEO operation modules on the wall inside the elevator MR.

6-1.8 Elevator Hoistway Pit Sump and Sump Pump

For hydraulic elevator installations, the hoistway pit sump pump control system audible and visual alarm indicators and controls must be installed in the elevator machine room.

6-1.9 General Wiring requirements

6-1.9.1 Only electric wiring, raceways, and cables used directly in connection with the elevator are permitted inside the elevator machine room. Allowable wiring includes wiring for signals, lighting, heating, air conditioning, and venting of the elevator MR.

6-1.9.2 All conductors and optical fibers in the MR must be in conduit.

6-2 Elevator Hoistway

6-2.1 120 VAC Hoistway Lighting and Receptacles

A minimum of two 2-light, 1.2 m (4 ft) long fluorescent lighting fixtures must be provided for lighting of the elevator hoistway pit. The fixtures must have a one piece, molded, high-impact clear acrylic diffuser with a secure seal against dust and moisture. A similar fixture must be provided every 3 m (10 ft) vertically up the hoistway. The fixture at the top of the hoistway must be mounted on the ceiling.

6-2.1.1 For control of the hoistway lighting circuit, provide two 3-way switches inside the elevator hoistway, at a height of 48” above the top and bottom elevator landings. Mount the switches on the hoistway wall, adjacent to the hoistway entrance strike jamb. The lower level lighting switch must be located adjacent to the hoistway pit access ladder.

6-2.1.2 Pit lighting must provide a minimum of 10 fc at the pit floor in all areas of the pit.

6-2.2 General Wiring Requirements

6-2.2.1 Only electric wiring, raceways, and cables used directly in connection with the elevator are permitted inside the hoistway. Allowable wiring includes wiring for signals, lighting, heating, air conditioning, and venting of the elevator cab; also for fire protection, for pit sump pump, and for heating, lighting, and venting of the hoistway.

6-2.2.2 All conductors and optical fibers in the hoistway, except traveling cable, must be in conduit.

6-2.2.3 Traveling cables must be suspended by a self-tightening webbed hanger or internal suspension member.

6-3 Elevator Hoistway Pit

6-3.1 Sump pump Receptacle

Provide a dedicated simplex receptacle, without GFI protection, to supply the permanently installed sump pump. Mount sump pump receptacle 5'-0" (1524 mm) above elevator pit floor. Provide LED light to verify circuit is energized.

6-3.2 Hoistway Pit GFCI Receptacles

Provide a separate branch circuit supplying the hoistway pit lighting and a minimum of two duplex GFCI receptacles in the pit. Locate one receptacle on each side wall of the hoistway, at 54” (mm) above pit floor. For hydraulic elevators, provide one additional receptacle on the rear wall of the hoistway at a height of 3’ above the pit floor (for scavenger pump power).

6-3.3 NEMA 4 Electrical Equipment

All electrical equipment located less than 4’-0” (1219 mm) above the pit floor shall be weatherproof (NEMA4) and wiring shall be identified for use in wet locations in accordance with the requirements in NFPA 70.

CHAPTER 7

FIRE PROTECTION

Design and installation of the fire alarm and fire protection systems and components related to elevator function and control must be in accordance with this ITG and all applicable reference documents and building and safety codes. A listing of reference documents is provided as Attachment A. The elevator design must comply with the edition in effect at the time of contract award.

7-1 Fire Alarm System

7-1.1 Fire Alarm Initiating Devices

In accordance with the current NAVFAC Fire Protection UFC, smoke detectors must be provided at the following locations, for the actuation of elevator Firefighters' Emergency Operation (FEO):

a. All elevator lobbies
b. All elevator machine rooms
c. Top of the elevator hoistway, if sprinklers are provided at the top of the hoistway

7-1.1.1 Elevator Controller Interface with Fire Alarm System

The design of the fire detection and alarm system must include an effective interface with the elevator controller for actuation of Fire Fighter's Emergency Operation (FEO). Indicate detectors and connections on fire protection drawings or on electrical drawings if fire protection drawings are not provided. Coordinate with Electrical Engineer.

7-1.1.2 For current code compliance, the smoke detector/fire alarm initiating device system typically requires 3 to 4 relay modules for Firefighters' Emergency Operation. Mount FEO operation modules on the wall inside the elevator MR.

7-1.2 FEO Visual Indicator Intermittent Flashing

Firefighters' Emergency Operation must include intermittent flashing of all of the FEO Phase I and Phase II visual indicators when a smoke detector has actuated in the elevator MR or hoistway.

7-2 Fire Protection System

Automatic sprinkle protection is determined by the NAVFAC Fire Protection Program. In buildings protected with an automatic sprinkler system, design sprinkler system in accordance with NAVFAC FIRE Protection UFC 3-600-01 and the following.

7-2.1 Elevator Machine Room

Provide sprinkler protection in all elevator machine rooms, except in Italy. Provide a dedicated sprinkler line for the elevator MR.

7-2.1.1 A supervised shut-off valve, check valve, flow switch, and test valve must be provided in the sprinkler line feeding the elevator machine room. These items must be located outside of and adjacent to the machine room. Actuation of the flow switch shall remove power to the elevator by shunt trip breaker operation. Shunt trip actuation shall be instantaneous; the flow switch must not have time delay capability.

7-2.2 Top of Elevator Hoistway

Sprinkler protection, with a dedicated sprinkler line, must be provided at the top of the hoistway only for the following:

a. for hydraulic elevators with cylinder or supply piping extending above the second finished floor elevation
b. for all elevators that are not designed with a 2-hour fire rated hoistway

7-2.2.1 A supervised shut-off valve, check valve, flow switch, and test valve must be provided in the sprinkler line feeding the top of the hoistway. These items must be located outside of and adjacent to the top of hoistway. Actuation of the flow switch shall remove power to the elevator by shunt trip breaker operation. The flow switch must not have time delay capability.

7-2.3 Elevator Hoistway Pit

Provide a sprinkler in the pit only for hydraulic elevators that do not have a sprinkler at the top of the hoistway. Locate the sprinkler head no more than 2'-0" (609 mm) above the pit floor. Provide a dedicated sprinkler line for the hoistway pit only.

7-2.3.1 A supervised shut-off valve shall be provided in the sprinkler line feeding the pit. Locate the valve outside of and adjacent to the pit. Actuation of the pit sprinkler shall not remove power to the elevator by shunt trip breaker operation.

7-2.4 Flow Switch Test Valve and Piping

For each inspector's test valve, discharge piping must be provided and shall discharge to a drain location that can accept full flow. Discharge to janitor sinks or similar plumbing fixtures is not permitted.

7-2.5 Fire Extinguisher

A fire extinguisher must be provided and installed on the wall, inside the elevator machine room, on the strike side of the machine room door. Indicate location on MR drawings.

CHAPTER 8

ELEVATOR SYSTEMS AND COMPONENTS

Design and installation of all elevator systems and components must be in accordance with this ITG and all applicable reference documents and building and safety codes. A listing of reference documents is provided as Attachment A. The elevator design shall comply with the edition in effect at the time of contract award.

8-1 Elevator Machine Room

8-1.1 Elevator Hoist Machine

The elevator hoist machine, including hoist motor and assembly, must be located within the elevator machine room (MR).

8-1.1.1 Non-Proprietary Elevator Hoist Machine

The elevator hoist-machine must be a non-proprietary product and must comply with the following paragraphs.

8-1.1.1.1 The elevator hoist machine configuration and installation design must be mechanically and electrically interchangeable with a minimum of 3 other elevator manufacturer's hoist machines that are readily available in the elevator industry.

8-1.1.1.2 The elevator hoist machine manufacturer must provide comprehensive factory training to include installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. The manufacturer must have an established and documented schedule, with pricing, for factory training classes that have been provided for a minimum period of one year prior to contract award date of the applicable project.

8-1.1.1.3 The elevator hoist machine must be identified as available for purchase and installation by any licensed elevator contractor. In addition, all parts, diagnostic tools, and software must be available for purchase, installation, and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable.

8-1.1.2 The elevator hoist motor must be designed and installed so that motor amperage does not exceed nameplate motor amperage when the elevator is running in any direction or loading condition.

8-1.2 Elevator Controller

The elevator controller must be located in the elevator MR.

8-1.2.1 Non-Proprietary Controller

The elevator controller must be a non-proprietary microprocessor controller. The controller equipment, software, and manufacturer must comply with the following paragraphs.

8-1.2.1.1 The controller must be manufactured and sold by an elevator controller manufacturer that does not engage in installation, service, or maintenance of elevators.

8-1.2.1.2 The elevator controller manufacturer must provide comprehensive factory training to include controller installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. The manufacturer must have an established and documented schedule, with pricing, for factory training classes that have been provided for a period of one year prior to contract award date of the applicable project.

8-1.2.1.3 The elevator controller must be identified as available for purchase and installation by any licensed elevator contractor. In addition, all parts, diagnostic tools, and software must be available for purchase and installation and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable.

8-1.2.1.4 The elevator controller manufacturer must publish an industry competitive price listing for all controller parts, diagnostic tools, and software.

8-1.2.1.5 A desktop PC must be provided, with complete elevator controller interface capability and with the manufacturer's comprehensive package of installation and diagnostic software. The PC and software system must provide unrestricted access to all parameters, all levels of adjustment, and all flags necessary for installation, adjustment, maintenance, and troubleshooting of the elevator. Expiring software, degrading operation, and "key" access controls are not acceptable.

8-1.2.1.6 The elevator controller manufacturer must provide a technical support phone service with live technical support available during standard working hours. The service must be accessible to any licensed elevator contractor at an industry competitive price. The hot-line must provide technical support for installation, adjustment, maintenance, and troubleshooting of the elevator controller and elevator components.

8-1.2.2 The controller must be designed to automatically reestablish normal elevator operation upon any temporary loss of power, regardless of duration.

8-1.3 Elevator Motor Drive

8-1.3.1 For all elevators, electrical output from the elevator drive and controller must limit Total Harmonic Distortion to a maximum of 5%. No single harmonic may exceed 3%.

8-1.3.2 All gearless traction elevators must be equipped with regenerative motor drive units.

8-1.3.3 Electrical supply wiring between the elevator controller and the elevator drive motor must be run in a dedicated conduit that is separate from elevator control wiring (i.e. encoder and tachometer wiring).

8-1.3 Machine Room Sound Level

The acoustic output of any equipment in elevator machine room must not exceed 80 dBA, measured at any point in the elevator machine room.

8-1.4 Machine Room Cabinet

For storage of O&M Documentation and Wiring Diagrams, a locking metal cabinet must be provided and secured to the wall of the MR. Cabinet must have a minimum size of 20"W X 12"D X 30" H and must be sized large enough to accommodate all O&M Data and documentation.

8-1.5 Corrosion Protection

All phosphorus metal elevator equipment and building components in the elevator machine room must be painted with a minimum of one coat of enamel paint.

8-2 Elevator Hoistway

8-2.1 Elevator Hoistway Entrance Assemblies

8-2.1.1 For a two hour fire rated hoistway, a minimum 1 ½ hour fire rated hoistway entrance assembly must be installed at every landing.

8-2.1.2 For every landing, a one-piece nickel-silver, stainless-steel, or nickel-bronze entrance sill

must be installed. The top of the landing sill must be flush, within 1/16", with the top of the finish floor. The same material must be used for all hoistway and elevator cab entrance sills.

EXCEPTION: Freight elevators with vertical bi-parting doors must be equipped with a minimum 12" deep diamond-plate steel sill at each landing. Hoistway doors must be equipped with steel trackable-sill angles.

8-2.1.3 For every landing, the hoistway entrance assembly door frame must be solidly grouted to

a height of 5' above the landing sill.

8-2.1.4 For every landing, a hoistway door unlocking device must be installed to allow elevator and trained emergency personnel to open the hoistway door from the landing.

8.2.1.4.1 For all jurisdictions that do not permit a hoistway door unlocking device, a keyed escutcheon hole

insert must be installed at every landing. Access to the insert key must be limited to

elevator personnel.

8-2.2 Elevator guide Rails

T-section type guide rails must be used for all car and counterweight guide rails. Rail shanks must be painted with one coat of black enamel.

8-2.3 Elevator Hoistway Pit

8-2.3.1 The hoistway pit stop switch must be a “push-to-stop” type elevator stop switch.

8-2.3.2 Structural steel pit channels must be installed to serve as mounting surfaces for main guide rails, counterweight guide rails, car buffers, and counterweight buffers.

8-2.4 Corrosion Protection

All phosphorus metal elevator equipment and building components in the elevator hoistway must be painted with a minimum of one coat of black enamel paint, except where a coating of paint may affect the operation of the elevator and equipment.

8-3 Elevator Cab and Landing Fixtures

8-3.1 General Requirements

Unless otherwise specified by the Designer of Record, all elevators in a facility must be designed with cab and landing fixtures and panels of identical and uniform design, material, finish, and components. All fixtures and devices must be engraved to identify function and operating positions and backfilled with a contrasting color.

8-3.1.1 Vandal Resistant Fixtures and Buttons

All cab and landing fixtures must be industry standard, vandal resistant design with metal buttons and positive stop assembly design.

8-3.1.2 LED Illumination

All illuminating fixture components must utilize LED lighting for energy efficiency.

8-3.1.3 Fixture Switches and Keys

Elevator manufacturer's standard grade may be used for all key switches unless otherwise specified. For all keyed car and landing fixtures, a minimum of twelve keys must be provided for each unique cylinder.

8-3.2 Firefighters' Emergency Operation (FEO)

8-3.2.1 The FEO designated landing must be determined during the facility design process and identified in the design submittal package.

8-3.2.1.1 A separate FEO Phase I fixture must be provided at the designated fire response floor. FEO Phase I fixture must be mounted on the opposite side of the elevator entrance from the landing hall call fixture. FEO Operating Instructions must be engraved in the Phase I fixture and backfilled with a contrasting color.

8-3.2.1.2 Both the FEO Phase I and Phase II visual indicators must be designed to operate with flashing operation
to indicate when a fire alarm initiating device has actuated in the elevator MR and/or hoistway.

8-3.2.1.3 The FEO Phase II Firefighters' Operation Panel must be located in the elevator cab Car
Operating Panel. FEO Phase II Operating Instructions must be engraved on the inside face of the Phase II Firefighters' Operation Panel cover and backfilled with a contrasting color.

8-3.3 Car Operating Panel (COP)

In addition to items required by safety code, the elevator COP must include the following:
Passenger accessible devices:

- illuminating "Alarm" button
- key-operated "Independent Service" switch
- momentary push-button communication device for emergency voice communication with both the elevator MR and an emergency desk that is manned continually, 7 days a week and 24 hours a day.

Behind a locked service panel:

- toggle type cab lighting on/off switch
- toggle type two-speed cab fan switch
- key operated "Hoistway Enable" switch for Hoistway Access Operation
- key operated "In-Car Inspection Operation" switch

8-3.4 Elevator Landing Fixtures

8-3.4.1 A hall call riser must be provided adjacent to each elevator.

8-3.4.2 All elevator hall call fixtures must be engraved with the ASME A17.1 "Elevator Corridor Call Station" pictograph. Pictograph must be engraved and backfilled with a contrasting color.

8-3.5 Hoistway Access Switches

All elevators must be equipped with hoistway access operation, with switches at the top and bottom terminal landings. Locate switch 1800 mm (6 feet) above floor level, within 300 mm (12 inches) of elevator hoistway entrance frame or with the ferrule exposed when located in

the elevator entrance frame.

8-3.6 Emergency Lock Box

For every elevator, a keyed lockbox must be provided at the FEO Designated Landing. The lockbox must be flush mounted in the wall, adjacent to and within 20" of the hoistway entrance assembly. Locate lockbox at a height of 60" above the landing sill. The lockbox must have a minimum size of 6"W X 8"H X 1.25"D. The locking mechanism must utilize the ASME A17.1 FEO key.

8-4 Elevator Car and Counterweight Components

8-4.1 Roller Guides

Coil-spring loaded roller guide assemblies must be installed in adjustable mountings on each side of the elevator car and counterweight frames, in accurate alignment at top and bottom of frames. Mounting assemblies must include integral seismic retainer plates.

8-4.2 Car Door Operator

The elevator car door operator equipment and circuitry must be designed and installed as discreet communication. Serial communication must not be used for this system.

8-4.3 Infra-red Car Door Protection

An Infra-red Curtain Unit (ICU), with a minimum of 150 beams, must be used to protect the full height and width of the car door opening.

8-5 Hydraulic Elevator Components and Systems

For all projects, direct plunger hydraulic elevators must be utilized in Navy Facilities. Roped-hydraulic elevators must not be installed in Navy facilities without written authorization and exception from the cognizant NAVFAC FEC VTE Program LCO .

8-5.1 Hydraulic Cylinder/Plunger Assemblies

The Hydraulic Cylinder/Plunger Assembly design must comply with the following:

a. Telescopic plungers must not be installed in Navy Facilities

b. Inverted cylinder/plunger assemblies must not be installed in Navy Facilities.

8-5.2 Hydraulic Elevator Machine/Pump Unit

8-5.2.1 Hydraulic Control Valve

Every hydraulic elevator must be equipped with a down-speed regulated control valve. In both directions of travel and in all loading conditions, the control valve must operate the elevator at a minimum of rated speed and at a maximum of 110% of rated speed.

8-5.2.1.1 The hydraulic control valve must have built-in adjustment capability to operate the elevator at 140% of rated speed, to facilitate periodic testing of the over-speed safety valve.

8-5.2.2 Hydraulic Working Pressure

The hydraulic system must be designed and installed so that the working pressure of the

elevator, running in the up direction, at rated speed, with rated load, does not exceed 500 psi.

8-5.2.3 Hydraulic Pump Motor
The hydraulic pump and motor must be designed and installed so that motor amperage does not exceed nameplate motor amperage when the elevator is running in the up direction, at rated speed, with rated load.

8-5.2.3.1 The hydraulic pump motor must be rated for 120 starts per hour and a minimum Class F insulation.

8-5.2.4 Motor Control
The hydraulic elevator motor control must utilize an electronic, soft-start motor starter.

8-5.2.5 The elevator system must be designed for and must operate to maintain the hydraulic fluid temperature within the optimum operating range specified by the hydraulic control valve manufacturer.

8-5.2.6 The hydraulic fluid reservoir capacity must be designed for and supplied with a minimum of full plunger displacement plus 38 liters (10 gal).

8-5.3 Hydraulic Safety Valve
Every hydraulic elevator must be equipped with a safety valve, installed directly adjacent to the hydraulic cylinder. For single cylinder designs, the safety valve must be attached to the cylinder with a connection
that is threaded or bolted directly to the hydraulic cylinder. For dual cylinder designs, the safety valve must be located as close as possible and equidistant from both cylinders.

8-5.4 Hydraulic Oil Supply Piping

8-5.4.1 Hydraulic oil supply line, from the hydraulic control valve to the hydraulic cylinder, must include the following:
a. Schedule 80 piping
b. Threaded or welded fittings
c. Manual shut-off valves in the elevator machine room and in the hoistway pit. Shut-off valves must be full-flow, 1/4 turn ball valves.
d. Dielectric union or isolation coupling at each end of the hydraulic oil supply line

8-5.4.2 Hydraulic oil lines must remain in or under conditioned space from end to end and remain within the building footprint. For all buried hydraulic lines between machine room and hoistway, provide straight pipe run in PVC pipe sleeves. Inside diameter of the PVC must be a minimum of 4” larger than the outside diameter of the supply line fittings.

8-5.5 Hydraulic Oil Scavenger Pump
A scavenge oil reservoir with strainer and transfer pump must be provided for every hydraulic

elevator. The scavenger pump unit must include a manual-reset pit flood switch to prevent pump operation if pit is flooded. Pump and reservoir must be anchored to the pit floor.

8-5.6 In-Ground Hydraulic Cylinder Protection

The exterior surface of in-ground hydraulic cylinders must be factory finished with a minimum 50 mils coating of either Applied Extruded Coating or Epoxy Resin.

8-5.6.1 In-Ground Hydraulic Cylinder Well Casing

A dry, plumb, steel well casing must be provided for every in-ground cylinder assembly. The well casing must be located according to the elevator manufacturer's design. The well casing must have a minimum 6 mm (1/4") wall and a welded 10 mm (1/2") steel bottom.

8-5.6.2 In-Ground Hydraulic Cylinder PVC or HDPE Liner

A Schedule 40 PVC or HDPE hydraulic cylinder liner must be provided for corrosion protection of the hydraulic cylinder and for containment of hydraulic fluid in the event of cylinder failure. The liner design and installation must comply with the following criteria:

a. The liner must be sealed to the cylinder mounting flange. The connection of the liner to the cylinder must be designed to support the combined weight of the liner and any accumulated hydraulic fluid, to the full capacity of the installed liner.
b. A 19 mm (1/4") copper evacuation tube must be installed inside the liner, from the bottom of the liner to the cylinder mounting plate. The evacuation tube must be run through the cylinder mounting plate and extend a minimum of 6" above the plate. The evacuation tube must be fitted with a plastic dust cap.
c. A metal pressure test manifold must be attached to the upper side of the cylinder mounting plate, for pressure testing of the liner and evacuation tube. The pressure test manifold must include a one-way, compressed-air inlet-valve and a 138 kPag (20 psi) safety relief valve.
d. The complete system must be designed and built to withstand a pressure test of 207 kPag (30 psig). The pressure test must be performed after complete assembly and installation of liner, cylinder, and liner evacuation system.
e. Gaps between casing, liner, and cylinder must be sealed with 4" thick, 21 MPa (3000 psi) grout. The top of the grout must be flush with the finish floor of the pit.

8-5.6.3 In-Ground Hydraulic Cylinder Liner Moisture Sensor System

Moisture and oil sensors must be installed inside the cylinder liner for detection of oil and/or water at the bottom of the cylinder liner. The monitoring system controls and audible and visual alarms must be installed in the elevator machine room and must include separate visual alarms for water and for oil.

8-5.6.4 Cylinder Liner Pressure Test

Following the complete assembly and installation of the cylinder/liner protection system, the entire assembly must be pressure tested to ensure the integrity of the fully sealed unit. For safety code compliance, periodic pressure testing is used to verify the integrity of the system. Comply with the following:

a. Perform a 30 minute pressure test at the beginning of the Acceptance Test, when the hydraulic fluid as close as possible to ambient temperature.
b. Perform a minimum 104 kPag (15 psig) pressure test of sealed system. For elevators with a travel greater than 30', perform pressure test at 138 kPag (20 psig).
c. Perform test from a remote location, outside of the elevator hoistway.
d. Utilize an air pressure admission throttle and shut-off valve.
e. Utilize additional pump unit safety relief valve set to relieve at 138 kPag (20 psig).
f. Utilize pressure gauge scaled for identification of 1 pound increments and calibrated at 0.5 percent accuracy.
g. Perform test in the presence of, and witnessed by, a NAVFAC Certified VTE Inspector.

8-5.7 Roped-Hydraulic Elevator Systems

For all projects, direct plunger hydraulic elevators must be utilized in Navy Facilities. Roped-hydraulic elevators must not be installed in Navy facilities.

EXCEPTION: In the event of compelling design conditions, the use of a roped-hydraulic elevator may be appropriate. Approval for use of a roped-hydraulic elevator design may be requested, on an individual project, by submission of a written Request for Approval to the NAVFAC VTE Program FEC Lead Certifying Official (LCO). The LCO is authorized to grant an exception to this restriction.

8-5.7.1 All roped-hydraulic plungers must be equipped with an over-travel limit switch. Limit switch must remove power from the hydraulic pumping unit and prevent the plunger stop ring from striking the head of the hydraulic cylinder.

8-5.7.2 All roped hydraulic elevators must have the following sign installed in the elevator MR:

"NOTICE: This is a Roped-Hydraulic Elevator. Emergency personnel shall not actuate the manual lowering valve. If movement of the elevator cab is necessary for extrication of passengers, contact the elevator service provider."

8-6 Elevator performance Testing and Commissioning

8-6.1 Performance Requirements

During the commissioning process, elevators must be inspected and tested for conformance to speed and pressure requirements and for performance and reliability.

8-6.1.1 Elevator speeds must be tested and recorded with the elevator running with no load, in both directions, and with rated load, in both directions. For each test to be considered successful, the elevator must run at a minimum of rated speed and at a maximum of 110% of rated speed.

8-6.1.2 Working pressure

8-6.1.2 Elevator performance and reliability must be tested by running the elevator, with rated load, for a continuous one-hour period. The elevator must run in both directions of travel, stop at each floor, and allow automatic door open and close operation. The requirements for Automatic Operation, Rated Speed, Leveling, Temperature Rise, and Motor Amperes must be met throughout the duration of the Endurance Test. The one-hour test period must be restarted from the beginning, following any shutdown or failure.

8-7 Elevator Supporting Documentation

8-7.1 O&M Data Package

For all elevator construction and modernization, all shop drawings and product data material must be assembled into O&M Data Packages. Two complete hard copy data packages and two complete electronic data packages, on separate CDs, must be provided. Comprehensive computer diagnostic documentation and software shall be included in the electronic data packages.

8-7.2 Wiring Diagrams

For each controller, two complete sets of full size, as-built wiring diagrams must be provided. One set must be laminated and mounted in the elevator MR. In addition, two complete electronic sets of as-built wiring diagrams must be provided on separate CDs, in PDF format. Coded wiring diagrams are not acceptable unless fully identified.

8-7.3 Component Submittals

For each hydraulic component that is subject to hydraulic oil pressure, the product submittal package must include the component manufacturer's product data identifying the working pressure for hydraulic elevator use, factor of safety, and ultimate strength.

APPENDIX A: Design Reference Documents

Design elevator, hoistway, and machine room in accordance with this ITG and with the current versions of the following reference documents. The elevator design shall comply with the edition in effect at the time of contract award. This listing of references is not exclusive. If there are government or non-government standards, codes, or criteria documents that apply, they are applicable regardless of whether or not they are included in this list.

ABAAS	- Architectural Barriers Act Accessibility Standard
ASME A17.1	- Safety Code for Elevators and Escalators
ASME A17.3	- Safety Code for Existing Elevators and Escalators
ASME A18.1	- Safety Standard for Platform Lifts and Stairway Chairlifts
ASME QEI-1	- Standard for the Qualification of Elevator Inspectors
NFGS - 14210	- NAVFAC Guide Specification, "Electric Traction Passenger Elevators"

NFGS - 14210 - NAVFAC Guide Specification, "Electric Traction Freight Elevators"
NFGS - 14240 - NAVFAC Guide Specification, "Hydraulic Passengers Elevators"
NFGS - 14240 - NAVFAC Guide Specification, "Hydraulic Freight Elevators"

NFPA 70 - National Electric Code (NEC)
IBC - International Building Code
IPC - International Plumbing Code

SEI/ASCE 24, Flood Resistance Design and Construction.

FEMA - 302, February 1999 - NEHRP Recommended Provisions for Seismic. Regulations for New Buildings and Other Structures. Part 1 Provisions.

TI 809-04, 31 December 1998 - TRI-Service Instruction, Seismic Design for Buildings.

Elevator Industry Field Employee Safety Handbook

National Elevator Industry, Inc. – Vertical Transportation Standards. Copies of this standard may be obtained from; National Elevator Industry, Inc., 400 Frank W. Burr Blvd., Teaneck, NJ 07666-6801; Telephone: (201) 928-2828.

UFC 3-600-01 - Fire Protection Engineering for Facilities

2-1.2 The design criteria provided in this Elevator Design Guide are applicable to both continental United States and overseas projects, however the technical/commercial reference standards (ASME, NEC, ADAAG) listed in this document will be different in Europe.

APPENDIX B: NAVFAC VTE PROGRAM POC

NAVFAC VTE Program Manager, Kevin P. Morse
(757) 322-4653 kevin.p.morse@navy.mil

NAVFAC VTE Deputy Program Manager, Dale Hughes
(757) 322-8216 dale.hughes@navy.mil

NAVFAC Facility Engineering Command (FEC) Lead Certifying Officials

NAVFAC Washington	NAVFAC Northwest	NAVFAC Hawaii
Michael Bruegging, LCO	Monte McPherson	David Cole, LCO

(202) 685-8412

(360) 476-5097

(808) 471-4742

NAVFAC Southeast
Robert Gober, LCO
(904) 542-4558

NAVFAC Midwest
Charlie Farmer
(812) 854-5386

NAVFAC Southwest
Joseph Ortiz, LCO
(619) 542-8568

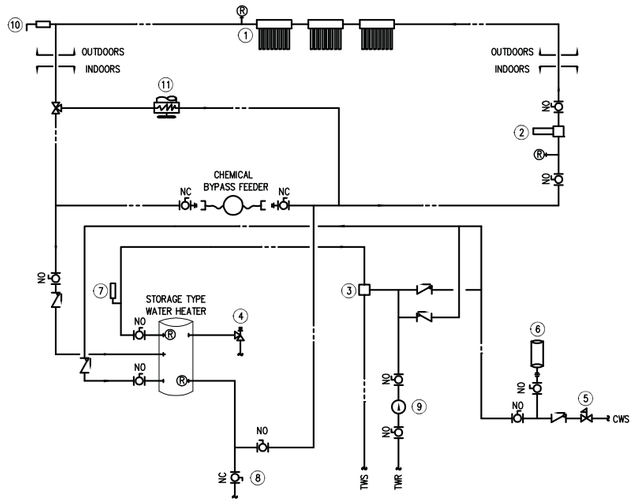
NAVFAC Midlant
William Landon (LCO)
(757) 462-4750

NAVFAC Far East
Hisao Igarashi
DSN 243-7507

NAVFAC Eur SWA
Alessandro Comiti, LCO

alessandro.comiti.IT@eu.navy.mil

NAVFAC Marianas
Mauro Narvarte
mauro.narvarte@fe.navy.mil

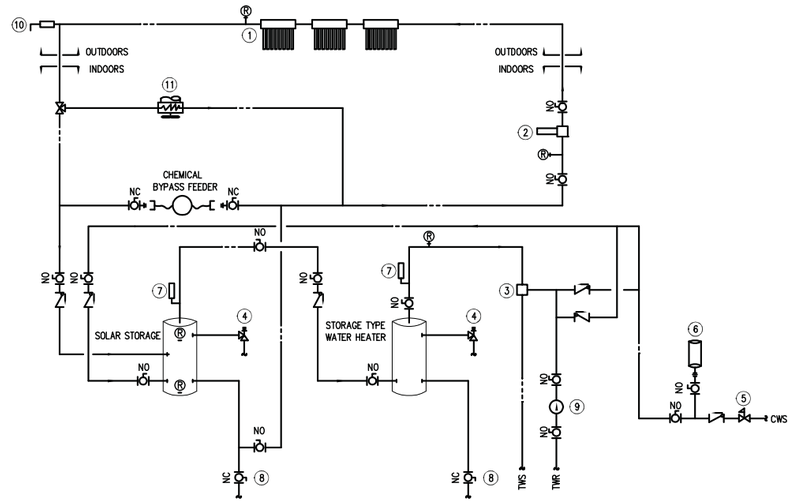


KEYED NOTES:

1. INSTALL SOLAR COLLECTORS IN SERIES UP TO 6 UNITS – THEN IN REVERSE FLOW PARALLEL MANIFOLD UP TO 24 UNITS.
2. SOLAR CONTROL AND PUMP STATION. CONNECT TO ALL RTD'S (Ⓡ).
3. MIXING VALVE.
4. ROUTE T&P RELIEF VALVE DISCHARGE FULL SIZE TO FLOOR DRAIN.
5. PRESSURE REDUCING VALVE – INSTALL ONLY IF WATER SUPPLY PRESSURE EXCEEDS 75% OF WATER HEATING SYSTEM DESIGN PRESSURE.
6. ASME THERMAL EXPANSION TANK – SIZE ACCORDING TO MANUFACTURER'S RECOMMENDATION.
7. COMBINATION TEMPERATURE AND PRESSURE GAUGE – INSTALL WITHIN 12" OF WATER HEATER OUTLET.
8. PROVIDE FULL–PORT VALVE AND ROUTE TO FLOOR DRAIN.
9. RECIRCULATION PUMP. PROVIDE AQUASTAT ONLY IF REQUIRED BY CODE WITH LETTER TO OWNER REQUIRING RELEASE OF LIABILITY (NON MOVING WATER PROMOTES LEGIONELLA).
10. FREEZE PROTECTION VALVE, ¾" IC/FP–035, INSTALL ON COMMON SOLAR HOT WATER RETURN LINE TO DISCHARGE ON ROOF. VALVE AND TEE TO REMAIN UN–INSULATED.
11. FAN COIL UNIT SIZED TO DISCHARGE AT LEAST 6,000 BTUH PER COLLECTOR, 3 PORT VALVE TO DIVERT COLLECTOR LOOP TO FAN COIL WHEN STORAGE TANK REACHES 180°. DUCT DISCHARGE THROUGH NEAREST OUTSIDE WALL.

DOMESTIC HOT WATER FLOW DIAGRAM
SINGLE WATER HEATER
WATER HEATER IS THE STORAGE TANK

SCALE: NONE

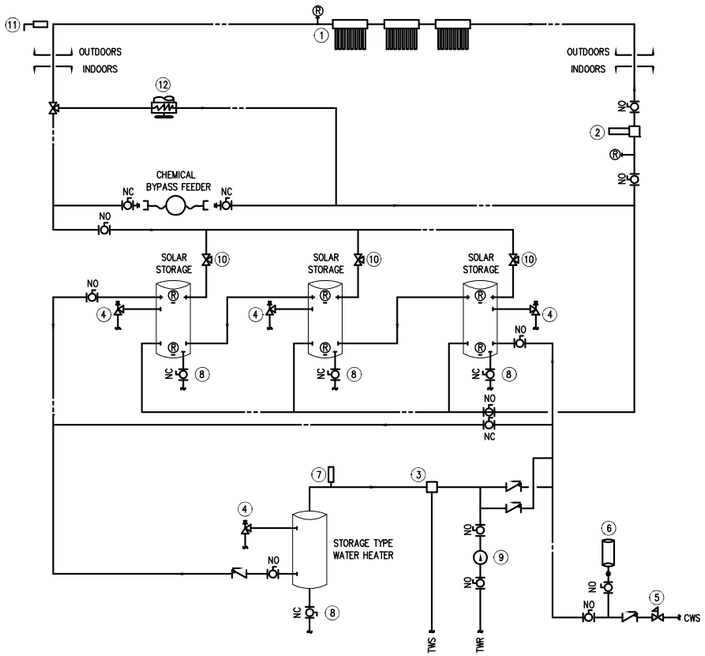


KEYED NOTES:

1. INSTALL SOLAR COLLECTORS IN SERIES UP TO 6 UNITS – THEN IN REVERSE FLOW PARALLEL MANIFOLD UP TO 24 UNITS.
2. SOLAR CONTROL AND PUMP STATION. CONNECT TO ALL RTD'S (Ⓡ).
3. MIXING VALVE.
4. ROUTE T&P RELIEF VALVE DISCHARGE FULL SIZE TO FLOOR DRAIN.
5. PRESSURE REDUCING VALVE – INSTALL ONLY IF WATER SUPPLY PRESSURE EXCEEDS 75% OF WATER HEATING SYSTEM DESIGN PRESSURE.
6. ASME THERMAL EXPANSION TANK – SIZE ACCORDING TO MANUFACTURER'S RECOMMENDATION.
7. COMBINATION TEMPERATURE AND PRESSURE GAUGE – INSTALL WITHIN 12" OF WATER HEATER OUTLET.
8. PROVIDE FULL–PORT VALVE AND ROUTE TO FLOOR DRAIN.
9. RECIRCULATION PUMP. PROVIDE AQUASTAT ONLY IF REQUIRED BY CODE WITH LETTER TO OWNER REQUIRING RELEASE OF LIABILITY (NON MOVING WATER PROMOTES LEGIONELLA).
10. FREEZE PROTECTION VALVE, ¾" IC/FP–035, INSTALL ON COMMON SOLAR HOT WATER RETURN LINE TO DISCHARGE ON ROOF. VALVE AND TEE TO REMAIN UN–INSULATED.
11. FAN AND COIL UNIT SIZED TO DISCHARGE AT LEAST 6,000 BTUH, PER COLLECTOR, 3 PORT VALVE TO DIVERT COLLECTOR LOOP TO FAN COIL. DUCT DISCHARGE THROUGH NEAREST OUTSIDE WALL.

DOMESTIC HOT WATER FLOW DIAGRAM
WATER HEATER WITH
SINGLE SOLAR STORAGE TANK

SCALE: NONE



KEYED NOTES:

1. INSTALL SOLAR COLLECTORS IN SERIES UP TO 6 UNITS – THEN IN REVERSE FLOW PARALLEL MANIFOLD UP TO 24 UNITS.
2. SOLAR CONTROL AND PUMP STATION. CONNECT TO ALL RTD'S (Ⓡ), AND SOLENOID VALVES (⑩).
3. MIXING VALVE.
4. ROUTE T&P RELIEF VALVE DISCHARGE FULL SIZE TO FLOOR DRAIN.
5. PRESSURE REDUCING VALVE – INSTALL ONLY IF WATER SUPPLY PRESSURE EXCEEDS 75% OF WATER HEATING SYSTEM DESIGN PRESSURE.
6. ASME THERMAL EXPANSION TANK – SIZE ACCORDING TO MANUFACTURER'S RECOMMENDATION.
7. COMBINATION TEMPERATURE AND PRESSURE GAUGE – INSTALL WITHIN 12" OF WATER HEATER OUTLET.
8. PROVIDE FULL–PORT VALVE AND ROUTE TO FLOOR DRAIN.
9. RECIRCULATION PUMP. PROVIDE AQUASTAT ONLY IF REQUIRED BY CODE WITH LETTER TO OWNER REQUIRING RELEASE OF LIABILITY (NON MOVING WATER PROMOTES LEGIONELLA).
10. SOLENOID VALVE.
11. FREEZE PROTECTION VALVE, ¾" IC/FP–035, INSTALL ON COMMON SOLAR HOT WATER RETURN LINE TO DISCHARGE ON ROOF. VALVE AND TEE TO REMAIN UN–INSULATED.
12. FAN AND COIL UNIT SIZED TO DISCHARGE AT LEAST 6,000 BTUH, PER COLLECTOR, 3 PORT VALVE TO DIVERT COLLECTOR RETURN FROM STORAGE TANKS TO THE FAN COIL. DUCT DISCHARGE THROUGH NEAREST OUTSIDE WALL.

STANDALONE SOLAR HOT WATER SYSTEM
SINGLE W/H WITH TRIPLE SOLAR STORAGE TANKS

SCALE: NONE

****
This specification section contains proprietary products.
****

SECTION 22 33 30.05 22

INTEGRATED PV-THERMAL SYSTEM
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE/SEI 7-05	(2006) Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2010) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 93	(2010) Methods of Testing to Determine the Thermal Performance of Solar Collectors
ASHRAE 96	(1980; R 1989) Methods of Testing to Determine the Thermal Performance of Unglazed Flat-Plate Liquid-Type Solar Collectors

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2004) Specification for Filler Metals for Brazing and Braze Welding

ASME INTERNATIONAL (ASME)

ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2010) Power Piping
ASME B40.100	(2005) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2007; Addenda 2008; Addenda 2009) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2010a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2010a) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A351/A351M	(2010) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A792/A792M	(2010) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 32	(2008) Standard Specification for Solder Metal
ASTM B 763	(2008a) Standard Specification for Copper Alloy Sand Castings for Valve Application
ASTM B 88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM D 1970	(2009) Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D 903	(1998; R 2010) Peel or Stripping Strength of Adhesive Bonds
ASTM E 1592	(2005) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E 1646	(1995; R 2003) Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Air Pressure Difference
ASTM E 1680	(1995; R 2003) Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems
ASTM E 2140	(2001; R 2009) Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head
ASTM E 283	(2004) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls,

	and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 330	(2002; R 2010) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 84	(2010b) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96/E 96M	(2010) Standard Test Methods for Water Vapor Transmission of Materials
ASTM F 1199	(1988; R 2010) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F 876	(2010) Crosslinked Polyethylene (PEX) Tubing
ASTM F 877	(2007) Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(1992; R 1993; Errata 2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-25	(2008) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011) National Electrical Code

SOLAR RATING AND CERTIFICATION CORPORATION (SRCC)

SRCC CSCWHSR	(2004) Summary of SRCC Certified Solar Collector and Water Heating System Ratings

SRCC OG-100	(1995) Operating Guidelines for Certifying Solar Collectors

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(1970; Rev B) Color Code for Pipelines & for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-59617	(Basic) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections

UNDERWRITERS LABORATORIES (UL)

UL 1703	(2002; Reprint May 2011) Standard for Safety Flat-Plate Photovoltaic Modules and Panels - Third Edition
UL 1741	(2010) Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources - Second Edition
UL 580	(2006; Reprint Jul 2009) Tests for Uplift Resistance of Roof Assemblies
UL 790	(2004; Reprint Oct 2008) Standard Test Methods for Fire Tests of Roof Coverings

1.2 SYSTEM DESCRIPTION

****
The system specified herein contains a proprietary system marketed by:
Dawn Solar Systems, Inc.
183 Route 125, Suite A-7
Brentwood, NH 03833
Phone: 866-338-2018
email info@dawnsolar.com
Webb site: www.dawnsolar.com
****

Provide an Integrated PV-Thermal System arranged for preheating of service (domestic and/or process) water using solar thermal collectors hidden from view, mounted beneath the standing seam roof and photovoltaic (PV) power system attached directly to the roofing panels. Include in the system all components required for the complete operation of the system. The system must not add to wind profile and the total weight must not exceed five (5) pounds per square foot.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Integrated PV-Thermal System

Solar thermal collecting system

Field Seam Metal Roof Panels

Shop drawings prepared specifically for this project; showing dimensions of metal roofing and accessories, fastening details and connections, and interface with other products.

As-Built Drawings

Include solar thermal collector structural supports, solar thermal collector control sequences, and instrument mounting and interconnections.

SD-03 Product Data

Piping

Instrumentation

Valves

Piping specialties

Pumps

Solar hot water storage tanks

Solar Thermal System Collectors

Heat exchangers

Solar-boosted domestic water heaters

Collector heat transfer fluid

Field Seam Metal Roof Panels

Manufacturer's catalog data, detail sheets, and specifications for each type of product provided.

Photovoltaic Power System

Include electrical diagram and installation drawings of the complete photovoltaic components including photovoltaic modules, inverter/transformer, fuses, cables, conductors, connectors, and all other related equipment.

Provide complete Photovoltaic material list as provided by photovoltaic manufacturer.

SD-04 Samples

Roofing panel

Submit a 12 inch long by full width section of typical panel.

For color selection, submit 2 by 4 inch metal samples in color, finish and texture specified.

SD-06 Test Reports

Inspection and Testing

SD-07 Certificates

Solar thermal collecting system installation

Submit technical representative's certification that the solar energy system installation has been done as recommended by the manufacturer.

Field Seam Metal Roof Panels

Provide written copy of certification program and approval letter from roofing manufacturer.

SD-08 Manufacturer's Instructions

Solar thermal collecting system

SD-10 Operation and Maintenance Data

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA Section 01 78 24.05 20 FACILITY OPERATION AND MAINTENANCE SUPPORT INFORMATION.

Solar thermal collecting system, Data Package

Photovoltaic Power System

Include equipment data sheets and installation/operation manuals for all major components.

SD-11 Closeout Submittals

Posted operating instructions for solar energy system and Photovoltaic Power System

1.4 QUALITY ASSURANCE

For brazing and soldering procedure qualification, conform to ASME B31.1; for preparation and procedures for joints, conform to ASME B31.1.

1.4.1 Photovoltaic Power System

Manufacturer's Qualifications: The manufacturer of the photovoltaic panels shall have a minimum of 10 years of successful experience continuously manufacturing solar electric panels of the type specified herein.

1.4.2 Field Seam Metal Roof Panels

Manufacturer's Qualifications: The roofing manufacturer shall have been in

the business as a roofing manufacturer for at least 10 years.

Installer Qualifications: Shall have been in the roofing installation business for a minimum of 5 years. Contractor must also be certified and approved installer of the sheet metal roofing manufacturer for installation of all components of roofing and solar assemblies.

1.4.3 Operation and Maintenance Data

Submit solar thermal collecting system data package for the following items:

a. Troubleshooting guide for solar energy systems

b. Solar thermal collector warranty

c. Operation instructions

d. Preventive maintenance and inspection data, including a schedule for system operators.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation, and dirt and dust or other contaminants.

Deliver photovoltaic system to job site properly packaged to provide protection against transportation damage. Adequately protect equipment placed in storage at the construction site that can be affected by weather conditions, dirt or other contaminants, and construction activities.

1.6 SYSTEM WARRANTY

Provide written warranty, executed by manufacturer, agreeing to repair or replace components of the entire building Integrated PV-Thermal System against defects in materials and or manufacturing workmanship for a period of 5 years from the date of complete installation and government acceptance.

1.6.1 Solar Thermal System Warranty

Provide written warranty, executed by the manufacturer agreeing to repair or replace integrated thermal system components against defects in materials and workmanship for a period of 25 years from the date of complete installation and government acceptance.

1.6.2 Field Seam Metal Roof Panels

Provide manufacturer's standard warranty document executed by authorized company official. Provide warranties as Follows:

a. Warranty covering the metal substrate against rupture, perforation, and structural failure due to normal atmospheric corrosion.

b. Warranty on paint finish against cracking, peeling, blistering, chalk, and color change.

c. Provide 35 year Kynar 500/Hylar 5000 limited finish warranty.

d. Provide 20 year warranty for substrate against corrosion and perforation.

Manufacturer's Weathertightness Warranty: Provide the manufacturers NDL roofing warranties for workmanship and material covering a period of 35 years from date of substantial completion and Government acceptance.

1.6.3 Photovoltaic Power System

Provide written warranty, executed by manufacturer, agreeing to repair or replace components of the entire building integrated photovoltaic system against defects in materials and or manufacturing workmanship for a period of five years from the date of complete installation and government acceptance.

Provide written warranty, executed by manufacturer, agreeing to repair or replace laminates that exhibit power output of less than 80% for a period of 20 years from the date of complete installation and government acceptance.

1.7 POSTED OPERATING INSTRUCTIONS

Provide for piping identification codes and diagrams of solar thermal system and diagrams of the photovoltaic power system, including operating instructions, control matrix, and trouble shooting instructions.

PART 2 PRODUCTS

2.1 SOLAR THERMAL COLLECTING SYSTEM

Provide the necessary materials to fabricate solar thermal collecting system in accordance with this section. **This specification is written with the Dawn Solar Thermal Collection System Model 3004L as manufactured by Dawn Solar Systems, Inc. as the basis of acceptable performance.** Provide factory-prefabricated solar thermal equipment packages which include heat exchanger, storage tanks, pumps and controls and which meet the requirements of this section. The solar thermal collecting system shall be valved to provide for shut-off from the service water supply without interrupting normal cold water service to the facility.

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Piping System

Piping system shall be complete with pipe, pipe fittings, valves, hangers, inserts, supports, anchors, guides, sleeves, and accessories. System materials shall conform to manufacturer's requirements. The piping from the manifold to hot water heaters will be copper.

2.1.2.1 PEX-AL-PEX Piping

Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX)

piping used for collector array. Piping and fittings shall conform to ASTM F 876 and ASTM F 877. Make all mechanical joints visible.

2.1.2.2 Copper Tubing

ASTM B 88, minimum Type L, hard drawn copper tubing, except that the connection tubes of collectors may be soft-drawn. Make all mechanical joints visible.

2.1.2.3 Hangers and Supports

MSS SP-58, as required by MSS SP-69.

2.1.2.4 Unions

CID A-A-59617, solder joint.

2.1.2.5 Strainers

ASTM F 1199, removable basket and screen, Y pattern, cast bronze strainer with pressures to 125 psig, simplex type; or a combination elbow-strainer with straightening vanes and strainer arranged for horizontal flow.

2.1.2.6 Pressure Gauges

ASME B40.100. Pressure gauges shall be provided with throttling type needle valve or a pulsation dampener and shutoff valve. Minimum dial size shall be 3-1/2 inch.

2.1.2.7 Thermostats

The system shall include temperature gauges so that an observer can determine if the system is operating properly and is providing solar heated water.

2.1.2.8 Dielectric Union

Provide insulated union with a galvanized steel female pipe-threaded end and a copper solder joint end conforming to ASME B16.39, Class 1. Provide a dry insulation barrier, impervious to water and capable of withstanding a 600 volt breakdown test and limiting galvanic current to one percent of the short circuit current in a corresponding bimetallic joint.

2.1.2.9 Valves

Ensure all valves comply with solar thermal collecting system manufacturer and solar thermal collecting system requirements. ASTM B 763 for brass valves and ASTM A216/A216M or ASTM A351/A351M. Provide end connections as indicated. Unless otherwise indicated, valves shall open when turned counterclockwise. In some cases, provide valves actuated by electric motors. Provide valve construction with rating indicated, MSS SP-25 marking modulating, brass or steel body construction, provide nonferrous or stainless steel valve seats and moving parts exposed to fluid, compatible with the operating conditions, and thermostatically controlled. Construct valves to permit replacing valve seals without draining the system. MSS SP-110 for threaded, socket-welding, solder joint, grooved and flanged ends.

2.1.3 Piping Specialties

2.1.3.1 Bolts and Nuts

Stainless steel; ASTM A193/A193M for bolts and ASTM A194/A194M for nuts.

2.1.3.2 Gaskets, Sealants and Couplings

Use fluorinated elastomers, ethylene-propylene-diene-terpolymer (EPDM) or silicone gaskets for system compatibility. Gaskets, sealants, and coupling hoses shall not be adversely affected by contact with fluids or the environment to an extent that will significantly impair their ability to function.

2.1.3.3 Brazing Metal

AWS A5.8/A5.8M, 15 percent silver-base alloy, minimum melting point 1,500 degrees F, for copper pipes rated at maximum 125 psi and 350 degrees F. Provide cadmium free filler metals.

2.1.3.4 Solder Metal

ASTM B 32, Alloy Grade Sb5, Sn95, or Sn96, with minimum melting 430 degrees F.

2.1.4 Piping Identification Labels

Plastic slip-on or adhesive backed labels conforming to MIL-STD-101.

2.1.5 Circulating Pumps

A variable or multiple speed AC or DC pump as designed and furnished by the manufacturer as part of the balance of system. The motors shall have sufficient power for the service required and be suitable for the available electric service and for the heat transfer fluid used, and shall conform to the requirements specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Circulating pumps shall be electrically-driven, single-stage, centrifugal type. The pumps shall have a capacity not less than that indicated. The pump shaft shall be constructed of corrosion resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal. Pumps shall have stainless steel impellers and casings of bronze. The motors shall be controlled by suitable switches that can be activated by either the differential temperature controller or by manual override (Hand-Off-Automatic). Each pump suction and discharge connection shall be provided with a pressure gauge as specified.

2.1.6 Solar Hot Water Storage Tanks

The solar hot water tanks shall be sized to accommodate the thermal systems output and furnished by the manufacturer as part of the balance of system. The [two (2)][_____] solar system hot water storage tank[s] shall have a storage volume of [450 gallons][_____] and shall be as shown on the drawings. Solar system storage tank shall conform to specifications for hot water storage tanks in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Tank penetrations shall be designed to allow for connections to copper piping without risk of corrosion due to dissimilar metals, and shall be factory installed as indicated.

2.1.7 Tank Insulations and Jackets

Comply with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Separate aboveground tanks from supports with insulation.

2.1.8 Mounting and Assembly Hardware

Mounting brackets and hinges shall be aluminum or stainless steel. Assembly hardware including all bolts, washers, and nuts shall be stainless steel.

2.1.9 Solar Thermal System Collectors

Site built solar thermal collection system shall be designed to occupy a one (1) inch of space between the waterproof roofing underlayment/reflective barrier and the roofing material. The solar thermal collector system will allow fastening of the roofing material directly to the roof deck. The solar thermal collector system shall comply with ASHRAE 93, ASHRAE 96, SRCC OG-100 and SRCC CSCWHSR. Supply with all materials necessary for integration into building's envelope. Include the following design features:

2.1.9.1 Solar Thermal System Collector Performance

Thermal performance shall be plotted on the thermal efficiency curve in accordance with ASHRAE 93. Manufacturer's recommended volumetric flow rate and the design pressure drop at the recommended flow rate shall be as shown on the drawings. Manufacturer's recommendations shall allow for balanced flow and for thermal expansion considerations.

2.1.9.2 Solar Thermal Collector System Weight

Maximum filled weight not to exceed 5 pounds per square foot of gross solar thermal system area.

2.1.9.3 Solar Thermal Collector System Layout

Solar thermal collector system shall consist of an assembly of solar thermal loops manifolded together as shown on the drawings. Solar collectors shall be assembled as shown. Minimum spacing between rows shall be as shown.

2.1.9.4 Solar Thermal Collector System Piping

The solar thermal collector system piping shall include interconnecting piping and manifolds between the solar thermal collector system loops, and shall be connected in the configuration as indicated on the drawings with approximately equal pipe length for any possible flow path. Flow rate through the solar thermalcollector system loops shall be as indicated on the drawings. Each component of the solar thermal collector system shall be capable of being isolated by valves. Manually operated air vents shall be located at system high points.

2.1.9.5 Supports for Solar Thermal System Collector

Support shall be provided by a pre-engineered sub purlin system on a properly prepared metal roof and installed in accordance with the recommendations of the solar thermal collector system manufacturer. Support structures provided by the solar thermal collector system

manufacturer may be used if they meet the stated specification. Support structure shall secure the solar thermal collector system as shown on the drawings. Support structure shall withstand static weight of the filled solar thermal collector system and piping, wind, snow, seismic, and other loads as indicated.

2.1.10 Heat Exchangers

The heat exchanger construction and testing shall be in accordance with ASME BPVC SEC VIII D1. Minimum design pressure rating shall be as shown. Provide relief vent with a visual indicator to detect leaks by the change of coloring in the heat transfer fluid.

2.1.11 Solar-Boosted Domestic Water Heaters

ASHRAE 90.1 - IP and UL listed. Provide built-in, double wall heat exchanger and factory insulation jacket.

2.1.12 Pipe Insulation

Pipe insulation and coverings shall be applied in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS as called out for steam piping to 15 psig. Solar thermal collector system piping insulation shall be capable of withstanding 250 degrees F, except that piping within 1.5 feet of collector connections shall be capable of withstanding 360 degrees F.

2.1.13 Expansion Tank

Expansion tank, fill and drain assemblies, mechanical thermostats, air scoops and vents in compliance with best practices as described by solar thermal collector system manufacturer. Expansion tank shall be constructed and tested in accordance with ASME BPVC SEC VIII D1 and as applicable for a working pressure of 125 psig. Expansion tank acceptance volume, total tank size and arrangement shall be as shown. Tank shall be provided with pressure relief valve. Tank shall be provided with precharged pressure as shown.

2.1.14 Heat Transfer Fluid

Solar collector loop fluid shall be uninhibited USP/food-grade propylene-glycol and shall be mixed with distilled or demineralized water to form a 50 percent by volume propylene-glycol solution as shown.

Conform to the following:

a. Liquid useful temperature range of -40 to 400 degrees F.

b. Non-ionic, high dielectric, non-aqueous, non-reactive, stable fluid which does not corrode copper, aluminum, iron, or steel, or attack plastics.

c. Flash point exceeding 380 degrees F.

d. Fluid stability of ten years.

e. Maximum acute oral toxicity of 5000 ppm.

2.1.15 Control and Instrumentation Subsystem

2.1.15.1 Solar Differential Control Equipment

A differential controller will operate the solar circulator based on a difference in temperature between the roof collector and the bottom of the solar storage tank. This temperature differential will be adjustable in the field. This unit will be furnished by the manufacturer as part of the balance of system and include an Energy Monitoring System. Differential temperature control equipment shall include a switching relay or solid state output device for pump control. Thermostat shall operate in the on-off mode. Controller accuracy shall be plus or minus 1 degree F. Controller shall be compatible with manufacturer supplied thermistor temperature sensors. Differential control shall provide direct digital temperature readings of all temperatures sensed. Control shall indicate visually when pumps are energized. Control ambient operating range shall be indicated by solar thermal collector system manufacturer.

2.1.15.2 Solar Energy Monitoring System

The solar energy monitoring system consist of a large graphic display with backlight that accommodates several languages, temperature sensors, variable speed pump control, manual test mode, easy to use interface with 1 GB SD card permanent memory storage. The system will record and view system data for energy, pump operation etc., with SD card interface. The system also provides a graphic view for 5 system configurations with extra functions, 2 Pump outputs, 2 Analog sensor inputs for flow and pressure, 1 Impulse flow meter input, pump exercise function. System capabilities include monitoring for errors such as short or open circuits to sensors, pump failure. Collector sensor location can be external or internal to collector.

2.1.15.3 Sensor and Control Wiring

Install in accordance with manufacturer's instructions, and applicable electrical and plumbing code standards. The control subsystem shall include such provision for bypass, adjustment or override controls as are required to facilitate installation, startup, operation, shutdown and maintenance of the system. Safety controls shall not have provision for bypass or override. All switches and their function shall be labeled and easily accessible.

2.1.15.4 Thermistor Temperature Sensors

Temperature sensors shall be multiple 1k type thermistor's units supplied by the differential temperature controller manufacturer, with an accuracy of plus or minus 1 percent at indicated temperature. Quantities will vary as a function of overall size.

2.1.16 Manifold

Provide supply and return manifold sets as part of each solar thermal collector system. Manifold sets may include actuators, balancing valves, flow rate indicators, pressure test assembly and other related accessories. Check and balance flow rates as needed. Verify that the manifold is mounted properly, located in an easily accessible location, and fasteners are tight.

2.2 FIELD SEAM METAL ROOF PANELS

Supply all material, labor, and equipment to complete:

a. Installation of standing seam metal roofing Pans' Support Structure

b. Preparation of Standing Seam Metal Roofing Pans for application of Photovoltaic "peal and apply" Laminates as described in paragraph PHOTOVOLTAIC POWER SYSTEM.

c. Application of Standing Seam Metal Roofing Pans and special roofing trim (as needed) to Support Structure, and over the Building Integrated Solar Thermal System as described in paragraph SOLAR THERMAL COLLECTING SYSTEM.

2.2.1 Structural Roofing Panel System

a. Mechanically Seamed Panels:

(1) Profile: 2 inch standing seam, heavy duty interlock clips.

(a) Width: 16 inches.

(b) Double-lock (180 degree seam).

(c) Wind Uplift Resistance: UL 580; Class 90.

(d) Hydrostatic-Head Resistance: No water penetration when tested in accordance with ASTM E 2140.

(e) Air leakage: Passed when tested in accordance with ASTM E 1680.

(f) Water Penetration: None when tested in accordance with ASTM E 1646.

(g) Flame Spread: Class 1 when tested in accordance with ASTM E 84.

(h) Uniform Static Air Pressure Difference: ASTM E 1592. Design Criteria 130 MPH winds computed in accordance with ASCE/SEI 7-05.

(i) Uniform Static Air Pressure Difference: ASTM E 330.

(j) FM Tested: Class 4471 wind uplift testing with a minimum rating of FM I-90.

(k) Class A Fire Rating, UL 790.

(l) Florida Building Code approval.

2.2.2 Materials

a. Galvalume: ASTM A792/A792M, AZ 50, aluminum-zinc alloy coating.

(1) Base Metal: Structural quality, 50 ksi yield point, 52 ksi tensile strength.

(2) Thickness: 24 gauge.

(3) Finish: Fluorocarbon Kynar 500/Hylar 5000 coating, nominal 1.0 mil

thickness comprised of 0.8 to 0.9 mil fluorocarbon full strength 70 percent Kynar 500 finish coating over 0.2 to 0.3 mil urethane primer. Specular Gloss shall be 25-40 percent when held measured at a 60 degree angle. Coatings shall be "cool colors" or Ultra-Cool for energy efficiency.

2.2.3 Underlayment Materials

a. Rubberized Asphalt Strips: Rubberized asphalt bonded to sheet polyethylene, 40 mil total thickness, with strippable treated release paper.

(1) Physical Properties:

(a) Load strain properties at 77 degrees F: maximum load (lbs/inch) MD/XD: 64/88. Elongation at maximum load (%) MD/XD: 52/24.

(b) Low Temperature Flexibility, ASTM D 1970: -22 degree F.

(c) Peel Resistance on plywood, ASTM D 903: 11.4lb/ft.

(d) Maximum Service Temperature: 240 degree F.

(e) Water Vapor Permeance, ASTM E 96/E 96M, perm: 0.017

(f) Air Permeability, ASTM E 283: <0.007

(g) Miami Dade Approved.

2.3 PHOTOVOLTAIC POWER SYSTEM

Photovoltaic modules shall be certified to meet UL 1703. All inverters shall be certified as meeting the requirements of UL 1741.

The manufacturer of photovoltaic panels shall have a minimum of 10 years of successful experience continuously manufacturing solar electric panels of the type specified herein.

Building Integrated Photovoltaic Generating System: The complete BIPV-T system shall be designed and supplied by the BIPV-T manufacturer for compatible integration of system components and for optimum system performance.

a. Photovoltaic Modules:

b. The PV laminates shall be lightweight and flexible with an adhesive, factory applied to back for direct installation on flat standing seam metal pans. the PV laminates must be designed to fit securely within the metal roofing pans without penetrating roofing material. The photovoltaic laminates shall have a high tolerance for shading from obstructions and debris. **This specification is written with the United Solar Ovonic, LLC as the basis of acceptable performance and appearance.** Like products of other manufacturers may be approved providing that they meet the entire requirement specified herein. Contractors are encouraged to submit both specified product and alternatives.

c. Balance of System Components:

(1) Inverter:

(a) The inverter shall be sized to accommodate the PV system layout. The inverter shall have at a minimum the following features: IEEE, UL 1741, IEEE 519, NFPA 70; Peak efficiency not less than 95% and NEMA 4 enclosure.

(b) PV module manufacturer as part of system without substitutions shall provide inverter.

(c) The inverter system will convert the DC power from the photovoltaic arrays to commercial AC power. The inverter is sized to match the capacity of the photovoltaic array and deliver the maximum energy to the load (grid).

(2) Isolation Transformer:

(a) Provide a power-conditioning transformer either with or within the inverter to complete the balance of system. The isolation transformer will be selected to match the maximum output of the system inverter.

(3) Combiner/J-Box:

(a) Provide hinged cover fiberglass or metal NEMA 4X enclosure unit that is sunlight resistant, and exhibits excellent chemical, temperature, and weather resistance properties.

(4) Disconnect Switch:

(a) Provide direct current (DC) disconnect switch to isolate system from inverter/transformer. The disconnect switch must be UL Listed with a main disconnect with fused switch to handle the inputs as specified by PV manufacturer.

2.4 PAINTING AND FINISHING

Equipment and component items, when fabricated from ferrous metal and located inside the building, shall be factory finished with the manufacturer's standard finish.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming thoroughly familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 SOLAR COLLECTOR INSTALLATION

3.2.1 Collector Subsystem

Collectors, tanks, pumps, valves, heat exchangers, piping, hoses and other components shall be capable of operating within design pressure and temperature ranges and withstanding environmental extremes anticipated in actual service without significantly reducing system design life. A rating for 180° F at 100 psi should be sufficient for all components located beneath the roof collector area.

3.2.1.1 Collector Array

Solar collector array shall be installed in accordance to the manufacturer's specifications. For mounting on pitched roofs, back of collectors shall be installed at 1 inches above roof surface. Each solar collector shall be removable for maintenance, repair, or replacement. Solar collector array shall not impose additional loads on the structure beyond the loads scheduled on the structural drawings.

3.2.1.2 Array Piping

Collector array piping shall be installed in a reverse-return configuration so that path lengths of collector supply and return are of approximately equal length. All piping must be coded with fluid type and flow direction labels in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.1.3 Array Support

Array support shall be provided by a pre-engineered sub purlin system on a properly prepared metal roof and installed in accordance with the recommendations of the collector manufacturer.

3.2.2 Storage Subsystem

Solar storage tank penetrations shall be installed as shown on the drawings so that cold water inlet to storage tank and outlet from storage tank to collector array are located near the bottom of the tank, and inlet from collector array and outlet to load are located near the top of the tank.

3.2.3 Transport Subsystem

3.2.3.1 Flow Rates

Flowmeters will be used for displaying and setting flow rate. System flow rate shall be based on recommended collector flow rate, and shall be as indicated. All flow rates shall be below 5 feet/second.

3.2.3.2 Pumps

Pumps shall be installed on foundations, leveled, grouted, and realigned before operation in accordance with solar energy collecting system manufacturer instructions. Additional pipe supports shall be provided as indicated. Drain line sizes from the pumps shall not be less than the drain trap or the pump dirt pocket, but in no case shall the drain line be less than 1/2 inch iron pipe size. Drain lines shall terminate to spill over the nearest floor or open sight drain.

3.2.3.3 Expansion Tank

Expansion tank shall be installed on suction side of pump as shown.

3.2.3.4 Piping, Valves, and Accessories

Piping shall be installed in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE, except where noted otherwise. Solders used on piping shall be as shown. Piping shall be coded with fluid type and flow direction labels in accordance with Section 09 90 00 PAINTS AND COATINGS. When a food-grade uninhibited propylene-glycol solution is used to heat

potable service water, tamper resistant seals must be attached to all fill ports. All propylene-glycol circuits must be labeled "CONTAINS UNINHIBITED FOOD-GRADE PROPYLENE-GLYCOL: INTRODUCTION OF ANY NONAPPROVED FLUID MAY CONSTITUTE A HEALTH HAZARD." All tamper resistant seals must carry the name of the registered engineer or licensed plumber who certifies that only a 50 percent food-grade uninhibited propylene-glycol and water solution has been installed in the system. Air vents shall be installed at the high points of the collector array and in the equipment room.

3.2.3.5 Pipe Expansion

Expansion of supply and return pipes shall be provided for by changes in the direction of the run of pipe or by expansion loops as indicated. Expansion loops shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Pipe guides shall be provided as indicated. Expansion joints shall not be used in system piping.

3.2.3.6 Valves

Valves shall be installed at the locations indicated and where required for the proper functioning of the system. Valves shall be installed with their stems horizontal or above. Ball valves shall be installed in flow and return in combination with check valves to prevent gravity and thermo circulation. Safety relief valves will be used to prevent over pressure.

3.2.3.7 Foundations

Concrete foundations or pads for storage tanks, heat exchangers, pumps, and other equipment covered by this specification shall be constructed in accordance with manufacturer's recommendations and be a minimum of 6 inches high with chamfered edges.

3.2.4 Control Subsystem

3.2.4.1 Differential Temperature Controller

Automatic control equipment shall be installed at the location shown in accordance with the solar energy collecting system manufacturer instructions. Control wiring and sensor wiring shall be installed in conduit. Unless otherwise indicated, operators, controllers, sensors, indicators, and like devices when installed on equipment casings and pipe lines shall be provided with stand-off mounting brackets, bases, nipples, adapters, or extended tubes to provide clearance, not less than the thickness of the insulation, between the surface and the device. These stand-off mounting items shall be integral with the devices or standard accessories of the controls manufacturer unless otherwise approved. Clamp-on devices or instruments where direct contact with pipe surface is required shall be exempted from the use of the above mounting items. All control wiring shall be color coded and identified with permanent numeric or alphabetic codes.

3.2.4.2 Sequence of Operation

The differential temperature controller sensing temperature difference between the fluid in a solar collector and water in the storage tank shall start and stop solar collector loop and storage loop pumps when the temperature differential (Delta T - ON) rises above manufacturer temperature specified.

3.3 FIELD SEAM METAL ROOF PANELS

3.3.1 Examination

Examine surfaces to receive sheet metal roofing. Notify the Architect in writing of any defective conditions encountered. Starting of work shall constitute acceptance of such conditions.

Metal Deck Substrate:

a. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves, or projections, and properly sloped.

b. Verify deck is dry and joints are solidly supported and fastened.

c. Verify wood nailers are installed and correctly located.

Structural Framing Substrate:

a. Verify primary and secondary framing members are installed and fastened, properly aligned and sloped.

b. Verify damaged shop coatings are repaired with touch up paint.

Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, reglets are in place, and nailing strips located. Ensure that adequate clearance for the PV panel wiring is provided at the ridge cap.

Correct defective conditions before beginning work.

3.3.2 Installation

Install in conformance with the NRCA Roofing and Waterproofing Manual and manufacturers installation instructions and recommendations. Form panel shape as indicated on drawings, accurate in size, square, and free from distortion or defects. Install underlayment as recommended by the manufacturer. Install all panels continuous from ridge to eave. Transverse seams are not permitted. All panels in excess of 40 feet shall be site formed. Where not otherwise indicated conform to SMACNA details including flashing and trim. Install sealants where indicated to clean, dry surfaces only without skips or voids.

3.3.3 Protection

Protect installed products until completion of project. Touch-up, repair or replace damaged products before Substantial Completion.

3.4 PHOTOVOLTAIC POWER SYSTEM

3.4.1 Preparation

Install complete electric connections, and similar items, as recommended by the equipment manufacturer and as required for proper operations according to these specifications and the drawings.

3.4.2 Installation

Install in accordance with manufacturer's instructions, and NFPA 70 standards.

Install photovoltaic laminates over flat metal roofing panels as shown on the drawings.

3.4.3 System Check-Out and Test

Provide the service of the manufacturer's trained certifier who shall visit the job site and verify the following:

a. Component Level: Check voltages and polarities at selected locations. Array strings are checked at the last module of the string. Combiner boxes, main array junction boxes; inverter and transformer are checked for physical damage.

b. Array Level: Check voltages, polarities and short circuit currents at combiner boxes. Module wiring is inspected and module output is tested at the combiner box. The combiner box is checked to ensure that it is mounted properly and fasteners are tight. Check voltages, polarities and short circuit currents at main combiner boxes. Check that inverter input voltage levels and polarities are correct. Sub-array wiring is inspected and sub-array output (V_{OC} and polarity) is tested at the main array junction boxes. Main array junction boxes are checked to ensure that they are mounted properly and fasteners are tight. Test balance of system housing ventilation systems.

c. Electrical Inspection and Approval: using a post-installation checklist and the maintenance checklist included in the Operations and Maintenance Manual, the entire system is physically inspected and electrically tested.

3.5 INSPECTION AND TESTING

3.5.1 Inspection

Make system available for inspection at all times.

3.5.2 Testing Prior to Concealment

3.5.2.1 Hydrostatic Test

Demonstrate to Contracting Officer that all piping has been hydrostatically tested, at a pressure of indicated by solar energy collecting system manufacturer for a period of time sufficient for inspection of every joint in the system and in no case less than 2 hours, prior to installation of insulation. Expansion tank and relief valves shall be isolated from test pressure. No loss of pressure shall be allowed. Leaks found during tests shall be repaired by replacing pipe or fittings and the system retested. Caulking of joints shall not be permitted.

3.5.2.2 Cleaning of Piping

System piping shall be flushed with clean, fresh water prior to concealment of any individual section and prior to final operating tests. Prior to flushing piping, relief valves shall be isolated or removed. Solar collectors shall be covered to prevent heating of cleaning fluid, unless

cleaning is performed during hours of darkness. The solution shall be circulated through the section to be cleaned at the design flow rate for a minimum of 2 hours.

3.5.3 Posting Framed Instructions

Framed instructions under glass or in laminated plastic shall be posted where directed. These instructions shall include a system schematic, and wiring and control diagrams showing the complete layout of the entire system. Condensed operating instructions explaining preventative maintenance procedures, balanced flow rates, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above, and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted for approval prior to posting. The framed instructions shall be posted before acceptance testing of the system.

3.5.4 Acceptance Testing and Final Inspection

Notify the Contracting Officer 7 calendar days before the performance and acceptance tests are to be conducted. Tests shall be performed in the presence of the Contracting Officer. Furnish all instruments and personnel required for the tests. Electricity and water will be furnished by the Government. A written record of the results of all acceptance tests shall be maintained, to be submitted in booklet form. The tests shall be as follows:

3.5.4.1 As-Built Drawings

Provide as a condition of final acceptance a complete set of as-built system drawings. Drawings shall clearly indicate the actual condition of the installed solar energy system at the time of the final test.

3.5.4.2 Final Hydrostatic Test

Demonstrate to Contracting Officer that all piping has been hydrostatically tested at a pressure indicated by manufacturer for a period of time sufficient for inspection of every joint in the system and in no case less than 2 hours. Expansion tank and relief valves shall be isolated from test pressure. Gauges used in the test shall have been calibrated within the 6-month period preceding the test. Test shall be witnessed by Contracting Officer. No loss of pressure shall be allowed. Leaks found during tests shall be repaired by replacing pipe or fittings and the system retested. Caulking of joints shall not be permitted.

3.5.4.3 System Flushing

For the final inspection, the system shall be thoroughly flushed, in no case for less than 2 hours, of all foreign matter until a white linen bag installed in a strainer basket shows no evidence of contamination. The white linen bag shall be in the strainer basket during the entire flushing operation prior to its being presented to the Contracting Officer for approval. The Contracting Officer will inspect the linen bag prior to completion of flushing and approve the flushing operation. System shall be drained prior to final filling.

3.5.4.4 System Filling

System shall be filled through indicated connections with propylene-glycol

solution. Solution shall be mixed externally to the solar system and consist of 50 percent propylene-glycol and 50 percent distilled water by volume. Air shall be vented from the system after filling. System pressure at the high point on the roof shall be as indicated by solar energy collecting system manufacturer.

3.5.4.5 Operational Test

Operational test shall occur over a period of 48 consecutive hours with sufficient solar isolation to cause activation of the solar energy system during daylight hours. With system fully charged so that pressure at the high point on the roof or the lowest system pressure set by manufacturer and with fluid and pumps energized, flowmeter must indicate flow. Calibrated balancing valves with pressure taps shall indicate bank flow rate as shown.

3.5.4.6 Control Logic

By substituting variable resistors for collector and storage tank temperature sensors, demonstrate the differential temperature controller correctly energizes the system pumps when the collector sensor indicates a temperature indicated on the controller display panel. The differential temperature controller shall de-energize the system pumps when the displayed temperature of the solar collectors reaches the displayed temperature of the storage tank.

3.5.4.7 Temperature Sensor Diagnostics

Demonstrate that the controller will correctly identify open and short circuits on both the solar collector temperature sensor circuit and the storage tank sensor circuit.

3.5.4.8 Overall System Operations

Demonstrate that the solar energy system will operate properly while unattended for a period of at least 72 hours and that the controller will start pumps after being warmed by the sun, and that it will properly shut down during cloudy weather or in the evening over a minimum of three complete cycles. Contractor is permitted to manipulate the temperature of the storage tank by the introduction of cold water at local groundwater temperature.

3.6 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Training shall be provided in accordance with solar energy collecting system manufacturer's requirements and shall start after the system is functionally complete but prior to final acceptance tests. The training shall include discussion of the system design and layout and demonstrations of routine operation and maintenance data and procedures. This training shall include: normal system operation and control; flow balancing; detection of a nonfunctioning system due to sensor, controller, and/or mechanical failure; filling, draining, and venting of the collector array; replacement of sensors, collectors, and collector components; collector cleaning and inspection for leaks; and heat exchanger cleaning and expansion tank charging if applicable.

-- End of Section --

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This specification section applies to MCB Camp Lejeune and MCAS New River projects only.
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SECTION 23 09 23.13 22

BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-D	(2007) Laboratory Methods of Testing Dampers for Rating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	WARNING: Text in tags exceeds the maximum length of 300 characters

ASME INTERNATIONAL (ASME)

ASME B16.34	(2009; Supp 2010) Valves - Flanged, Threaded and Welding End
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2010) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A 126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.45	(2002; R 2008) Recommended Practice on

	Surge Testing for Equipment Connected to Low-Voltage (1000v and less)AC Power Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8802-3	(2000) Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD)Access Method and Physical Layer Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011) National Electrical Code
NFPA 72	(2010; TIA 10-4) National Fire Alarm and Signaling Code
NFPA 90A	(2009; Errata 09-1) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006; Reprint Feb 2011) Surge Protective Devices
UL 506	(2008; Reprint Mar 2010) Specialty Transformers
UL 508A	(2001; Reprint Feb 2010) Industrial Control Panels
UL 916	(2007; Reprint Jun 2010) Standard for Energy Management Equipment

1.2 DEFINITIONS

1.2.1 ANSI/ASHRAE Standard 135

ANSI/ASHRAE Standard 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks, referred to as "BACnet". ASHRAE developed BACnet to provide a method for diverse building automation devices to communicate and share data over a network.

1.2.2 BACnet

Building Automation and Control Network; the common name for the communication standard ASHRAE 135. The standard defines methods and

protocol for cooperating building automation devices to communicate over a variety of LAN technologies.

1.2.3 BACnet/IP

An extension of BACnet, Annex J, defines this mechanism using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number. See also "BACnet Broadcast Management Device".

1.2.4 BACnet Internetwork

Two or more BACnet networks, possibly using different LAN technologies, connected with routers. In a BACnet internetwork, there exists only one message path between devices.

1.2.5 BACnet Network

One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.

1.2.6 BACnet Segment

One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.

1.2.7 BBMD

BACnet Broadcast Management Device (BBMD). A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Every IP subnetwork that is part of a BACnet/IP network must have only one BBMD. See also "BACnet/IP".

1.2.8 BAS

Building Automation Systems, including DDC (Direct Digital Controls) used for facility automation and energy management.

1.2.9 BIBBs

BACnet Interoperability Building Blocks. A collection of BACnet services used to describe supported tasks. BIBBs are often described in terms of "A" (client) and "B" (server) devices. The “A” device uses data provided by the "B" device, or requests an action from the “B” device.

1.2.10 BI

BACnet International, formerly two organizations: the BACnet Manufacturers Association (BMA) and the BACnet Interest Group - North America (BIG-NA).

1.2.11 BI/BTL

BACnet International/BACnet Testing Laboratories (Formerly BMA/BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.

1.2.12 Bridge

Network hardware that connects two or more network (or BACnet internetwork) segments at the physical and data link layers. A bridge may also filter messages.

1.2.13 Broadcast

A message sent to all devices on a network segment.

1.2.14 DADMS

DON Applicaiton and Database Management System, (DADMS) is a listing of digital applications approved for purchase and use.

1.2.15 Device

Any control system component, usually a digital controller, that contains a BACnet Device Object and uses BACnet to communicate with other devices. See also "Digital Controller".

1.2.16 Device Object

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.

1.2.17 Device Profile

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE 135, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing BIBBs supported and must be tested and listed by BACnet Testing Laboratory (BTL).

1.2.18 Digital Controller

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions. In most cases, synonymous with a BACnet device described in this specification. See also "Device". There are different levels of controllers, with varying levels or complexity and flexibility.

1.2.18.1 Terminal Device Controllers

Terminal device controllers typically are controllers with less control features, may have integrated actuators, and may be mounted directly on equipment (with enclosures).

1.2.18.2 Field Controllers

Field controllers typically have a greater capability for input/output and customization, do not have integral actuators, are mounted in an enclosure not on the equipment and are used for equipment such as VAV air handlers.

1.2.18.3 Plant Controllers

Plant Controllers are typically used to control various equipment in mechanical rooms such as pumps, heat exchangers, and chillers.

1.2.18.4 Supervisory Controllers

Supervisory Controller is used to coordinate all equipment in a building, input scheduling, and is often used as a connection point for transferring configuration files to the other controllers.

1.2.18.5 Supervisory Building Controller (SBC)

Supervisory Building Controller (SBC) is used to connect the building's DDC system (MS/TP) to Camp Lejeune's EMCS (TC/IP). Depending on approvals and capabilities, the SBC and supervisory controller may be combined into the same piece of hardware.

1.2.19 Direct Digital Control (DDC)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.2.20 DDC System

A distribution network of digital controllers, communication architecture, and user interfaces. A DDC system may include programming, sensors, actuators, switches, relays, factory controls, operator workstations, and various other devices, components, and attributes.

1.2.21 DITSCAP

Department of Defense Information Technology Security Certification and Accreditation Process (DITSCAP). DISCAP and DIACAP are processes that approve IP base equipment that is connected and communicates on the base Ethernet network. All devices using TCP/IP or Ethernet connectivity require prior approval to be listed in the DITSCAP and SSA document.

1.2.22 EMCS

Energy Management & Control System. The EMCS at Camp Lejeune is an enterprise system that actively receives energy and building condition information from multiple sources and provides load shedding, electric metering, alarming, trending, scheduling, set point adjustment and device status of all supervisory building controllers for maintenance personnel. The EMCS receives real time electrical utility pricing data and automatically manages to Camp Lejeune's energy target. The existing Camp Lejeune EMCS is manufactured by Johnson Controls and incorporates the Metasys extended architecture system that communicates over the MRAN.

1.2.23 EMCS Owner

The regional or local user responsible for managing all aspects of the BAS operation, including: network connections, workstation management, submittal review, technical support, control parameters, and daily operation. The BAS Owner for this project is Utility Monitoring & Control (UMAC) Director

1.2.24 Ethernet

A family of local-area-network technologies providing high-speed networking features over various media. Base Telephone manages all Ethernet connections to the IP networks.

1.2.25 Firmware

Software programmed into read only memory (ROM), flash memory, electrically erasable programmable read only memory (EEPROM), or erasable programmable read only memory (EPROM) chips.

1.2.26 Gateway

Communication hardware connecting two or more different protocols, similar to human language translators. The Gateway translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.

1.2.27 Half Router

A device that participates as one partner in a BACnet point-to-point (PTP) connection. Two half-routers in an active PTP connection combine to form a single router.

1.2.28 Hub

A common connection point for devices on a network.

1.2.29 Internet Protocol (IP, TCP/IP, UDP/IP)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.2.30 Input/Output (I/O)

Physical inputs and outputs to and from a device, although the term sometimes describes software, or "virtual" I/O. See also "Points".

1.2.31 I/O Expansion Unit

An I/O expansion unit provides additional point capacity to a digital controller.

1.2.32 IP subnet

Internet protocol (IP) identifies individual devices with a 32-bit number divided into four groups from 0 to 255. Devices are often grouped and share some portion of this number. For example, one device has IP address 209.185.47.68 and another device has IP address 209.185.47.82. These two devices share Class C subnet 209.185.47.00

1.2.33 Local-Area Network (LAN)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.2.34 MAC Address

Media Access Control address. The physical node address that identifies a device on a Local Area Network.

1.2.35 Master-Slave/Token-Passing (MS/TP)

ISO 8802-3. The standard LAN for BACnet. MSTP uses twisted-pair wiring for relatively low speed and low cost communication (up to 4,000 ft at 76.8K bps).

1.2.36 Native BACnet Device

A device that uses BACnet as its primary, if not only, method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.

1.2.37 Network

Communication technology for building network data communications. BACnet approved network types are Point to Point (PTP) Ethernet, and MS/TP. BACnet over Internet Protocol is not an approved method for building level controls.

1.2.38 Network Number

A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.

1.2.39 Object

The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.

1.2.40 Object Identifier

An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.

1.2.41 Object Properties

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.2.42 Peer-to-Peer

Peer-to-peer refers to devices where any device can initiate and respond to communication with other devices.

1.2.43 Performance Verification Test (PVT)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.2.44 PID

Proportional, integral, and derivative control; three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.2.45 PICS

Protocol Implementation Conformance Statement (PICS), describing the BACnet capabilities of a device. See BACnet, Annex A for the standard format and content of a PICS statement.

1.2.46 Points

Physical and virtual inputs and outputs. See also "Input/Output".

1.2.47 PTP

Point-to-Point protocol connects individual BACnet devices or networks using serial connections.

1.2.48 Repeater

A network component that connects two or more physical segments at the physical layer.

1.2.49 Router

A BACnet router is a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.

1.2.50 Stand-Alone Control

Refers to devices performing equipment-specific and small system control without communication to other devices or computers for physical I/O, excluding outside air and other common shared conditions. Devices are located near controlled equipment, with physical input and output points limited to 64 or less per device, except for complex individual equipment or systems. Failure of any single device will not cause other network devices to fail. BACnet "Smart" actuators (B-SA profile) and sensors (B-SS profile) communicating on a network with a parent device are exempt from stand-alone requirements.

1.2.51 SSAA

System Security Authorization Agreement. The SSAA is a local document authorizing the use of the IP networks on Camp Lejeune.

1.2.52 Supervisory Controller

Supervisory Controller is the upper level controller on the building's

MS/TP bus. It provides building wide points, scheduling, and interface with programming tools.

1.2.53 Supervisory Building Controller (SBC)

The Supervisory Building Controller is the point of connection between the Camp Lejeune EMCS network (IP) and the building level control network (MS/TP). The hardware at this location, that provides the connection is referred to as the SBC. Since the EMCS network uses the Marine Air-Ground Task Force Regional Area Network (MRAM) Ethernet network using TCP/IP, any equipment connecting to the Camp Lejeune EMCS must be listed in the approved DITSCAP or DIACAP equipment list and must be Marine Corps DADMS listed and approved.

1.3 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph entitled "Subcontractor Special Requirements" in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS. The paragraph specifies that all contract requirements of this section shall be accomplished directly by a first tier subcontractor. No work required shall be accomplished by a second tier subcontractor.

a. The controls sub-contractor for this project shall be regularly engaged in the design and installation of BACnet DDC systems (for building HVAC systems) similar to the size and scope of this project, shall have been a representative of the proposed control system manufacturer for a minimum of two years, have a staffed office within a 50-mile radius of the project location, and shall have performed design and installation of DDC systems for a minimum of 5 years.

b. The controls sub-contractor shall ensure that their installing electricians have a copy of, read, and understand the mechanical sheets of the contract's design construction drawings, in addition to the control drawings prepared by the sub-contractor. Provide the DDC programming and graphics using Standard English units of measure, not metric.

1.4 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC DESCRIPTION

a. Provide new BACnetand merge with existing BACnet DDC systems including associated equipment and accessories. DDC control panel shall be placed in Mechanical, Room G178. The existing DDC system is manufactured by Johnson Controls Metasys in the original HM2 Charles Luke Milam Aid Station building mechanical room, room G-119..

b. Provide a networked DDC system for stand alone control in compliance with the latest revision of the ASHRAE 135 BACnet standard. Include all programming, objects, and service required to meet the sequence of control. Provide BACnet communication between the DDC system and the native BACnet devices furnished with HVAC equipment, and plant equipment including boilers, chillers, and variable frequency drives. Devices provided shall be BACnet Testing Laboratories (BTL) product listing certified. Interface the new DDC system with Camp Lejeunes existing EMCS. Provide a Supervisory Building Controller (SBC) that shall communicate with the field DDC controllers via the MS/TP bus using BACnet, and with the EMCS via the Marine Air-Ground Task Force Regional Area Network (MRAM) Ethernet network using TCP/IP. Provide interface with the existing EMCS including graphic creation,

scheduling, alarming, load management scheduling and trending.

c. Authority to Operate/Authority to Connect: Prior approval to communicate on the base MRAN is a requirement on this project. Supervisory Building Controllers (SBC) and any other device communicating on the MRAN without being DADMS listed and approved and approval from the Designated Approving Authority based on DITSCAP or DIACAP efforts will not be permitted.

d. Only technicians authorized by the Camp Lejeune utilities department and factory trained on Metasys extended architecture are approved to add, manage or revise data in the EMCS. Authorization shall require a unique username and password managed by the Utilities Department. All equipment listed as being part of the DDC system shall have a defined energy load value and be entered into the base load rolling program. Graphics, naming, trending and overall user views shall be added to the EMCS. All points added shall be consistent with previously installed buildings.

1.4.1 Design Requirements

1.4.1.1 Control System Drawings Title Sheet

Provide a title sheet for the control system drawing set. Include the project title, project location, contract number, the controls contractor preparing the drawings, an index of the control drawings in the set, and a legend of the symbols and abbreviations used throughout the control system drawings.

1.4.1.2 List of I/O Points

Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), and point connection terminal number. Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria. All points shall adhere to the Camp Lejeune standard naming conventions.

1.4.1.3 Control System Components List

Provide a complete list of control system components installed on this project. Include for each controller and device: control system schematic name, control system schematic designation, device description, manufacturer, and manufacturer part number. For sensors, include point name, sensor range, and operating limits. For valves, include body style, Cv, design flow rate, pressure drop, valve characteristic (linear or equal percentage), and pipe connection size. For actuators, include point name, spring or non-spring return, modulating or two-position action, normal (power fail) position, nominal control signal operating range (0-10 volts DC or 4-20 milliamps), and operating limits.

1.4.1.4 Control System Schematics

Provide control system schematics. Typical schematics for multiple identical equipment are allowed unless otherwise requested in design or contract criteria. Include the following:

a. Location of each input and output device

b. Flow diagram for each piece of HVAC equipment

c. Name or symbol for each control system component, such as V-1 for a valve

d. Setpoints, with differential or proportional band values

e. Written sequence of operation for the HVAC equipment

f. Valve and Damper Schedules, with normal (power fail) position

1.4.1.5 HVAC Equipment Electrical Ladder Diagrams

Provide HVAC equipment electrical ladder diagrams. Indicate required electrical interlocks.

1.4.1.6 Component Wiring Diagrams

Provide a wiring diagram for each type of input device and output device. Indicate how each device is wired and powered; showing typical connections at the digital controller and power supply. Show for all field connected devices such as control relays, motor starters, actuators, sensors, and transmitters.

1.4.1.7 Terminal Strip Diagrams

Provide a diagram of each terminal strip. Indicate the terminal strip location, termination numbers, and associated point names.

1.4.1.8 BACnet Communication Architecture Schematic

Provide a schematic showing the project's entire BACnet communication network, including addressing used for LANs, LAN devices including routers and bridges, gateways, controllers, workstations, and field interface devices. If applicable, show connection to existing networks.

1.5 SUBMITTALS

Submit detailed and annotated manufacturer's data, drawings, and specification sheets for each item listed, that clearly show compliance with the project specifications.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control Approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Include the following in the project's control system drawing set:

Control system drawings title sheet; G

List of I/O Points; G

Control System Components List; G

Control system schematics; G

HVAC Equipment Electrical Ladder diagrams; G

Component wiring diagrams; G

Terminal strip diagrams; G

BACnet communication architecture schematic; G

SD-03 Product Data

Direct Digital Controllers; G

Include BACnet PICS for each controller/device type, including smart sensors (B-SS) and smart actuators (B-SA).

BACnet Gateways; G

Include BACnet and workstation display information; bi-directional communication ability; compliance with interoperability schedule; expansion capacity; handling of alarms, events, scheduling and trend data; and single device capability (not depending on multiple devices for exchanging information from either side of the gateway).

Notebook Computer; G

Sensors and Input Hardware; G

Output Hardware; G

Surge and transient protection; G

Duct smoke detectors; G

Variable frequency (motor) drives; G

SD-05 Design Data

Performance Verification Testing Plan; G

Pre-Performance Verification Testing Checklist; G

SD-06 Test Reports

Performance Verification Testing Report; G

SD-07 Certificates

Contractor's Qualifications; G

SD-09 Manufacturer's Field Reports

Pre-PVT Checklist; G

SD-10 Operation and Maintenance Data

Comply with requirements for data packages in Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified in this specification.

BACnet Direct Digital Control Systems, Data Package 4; G

Controls System Operators Manuals, Data Package 4; G

VFD Service Manuals, Data Package 4; G

SD-11 Closeout Submittals

DDC Software; G

Training documentation; G

1.6 QUALITY ASSURANCE

1.6.1 Standard Products

Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.

1.6.2 Delivery, Storage, and Handling

Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6.3 Operating Environment

Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.

1.6.4 Finish of New Equipment

New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be according to ASTM B 117, with acceptance criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 0.125 inch on either side of the scratch mark.

1.6.5 Verification of Dimensions

The contractor shall verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing work.

1.6.6 Contractor's Qualifications

Submit documentation certifying the controls Contractor performing the work has completed at least three DDC systems installations of a similar design to this project, and programmed similar sequences of operation for at least two years. Submit the name of the technician proposed to make

additions/alterations to the EMCS servers. Submit supporting documentation demonstrating their qualifications.

1.6.7 Modification of References

The advisory provisions in ASME B31.1 and NFPA 70 are mandatory. Substitute "shall" for "should" wherever it appears and interpret all references to the "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.6.8 Project Sequence

The control system work for this project shall proceed in the following order:

a. Submit and receive approval on the Shop Drawings, Product Data, and Certificates specified under the paragraph entitled "SUBMITTALS."

b. Perform the control system installation work, including all field check-outs and tuning.

c. Provide support to TAB personnel as specified under the paragraph "TEST AND BALANCE SUPPORT."

d. Submit and receive approval of the Controls System Operators Manual specified under the paragraph "CONTROLS SYSTEM OPERATORS MANUALS."

e. Submit and receive approval of the Performance Verification Testing Plan and the Pre-PVT Checklist specified under the paragraph "PERFORMANCE VERIFICATION TESTING."

f. Perform the Performance Verification Testing.

g. Submit and receive approval on the PVT Report.

h. Submit and receive approval on the Training Documentation specified under the paragraph "INSTRUCTION TO GOVERNMENT PERSONNEL" and "VFD Service Support". Submit at least 30 days before training.

i. Deliver the final Controls System Operators Manuals and VFD Service Manuals.

j. Conduct the Phase I Training and VFD on-site/hands-on training.

k. Conduct the Phase II Training.

l. Submit and receive approval of Closeout Submittals.

PART 2 PRODUCTS

2.1 DDC SYSTEM

Provide a networked DDC system for stand-alone control in compliance with the latest revision of the ASHRAE 135 BACnet standard. Include all programming, objects, and services required to meet the sequence of control. Provide BACnet MSTP communications between the DDC system and native BACnet devices furnished with HVAC equipment, and plant equipment such as boilers, and chillers when provided with BACnet MSTP communications. DDC controllers provided shall be certified in the BACnet

Testing Laboratories (BTL) Product Listing. BACnet over IP is not permitted.

2.1.1 Supervisory Building Controller (SBC)

Provide an SBC that communicates between the DDC system and the Camp Lejeune EMCS server. Provide all necessary hardware, drivers, software, material and equipment which shall allow communication and control between the SBC and the field DDC controllers using BACnet on the MS/TP bus. The SBC shall be capable of upload/download to and from the EMCS server. All SBC information shall transfer back to the EMCS system via the Ethernet TCP/IP level 1 network. All IP addresses and network drops shall be furnished by base telephone. Supervisory Building Controllers (SBC) must be listed and approved on the Marine Corps DADMS and listed in the sites DITSCAP SSAA documents. When the SBC is disconnected from the enterprise system for maintenance, access to the SBC shall be via a laptop computer with Internet Explorer and not require any proprietary licensed software or license key.

2.1.2 Direct Digital Controllers

Direct digital controllers shall be UL 916 rated.

2.1.2.1 I/O Point Limitation

The total number of I/O hardware points used by a single stand-alone digital controller, including I/O expansion units, shall not exceed 64. Place I/O expansion units in the same cabinet as the digital controller.

2.1.2.2 Environmental Limits

Controllers shall be suitable for, or placed in protective enclosures suitable for the environment (temperature, humidity, dust, and vibration) where they are located.

2.1.2.3 Stand-Alone Control

Provide stand-alone digital controllers capable of meeting the complete sequence of operation with and without network connectivity (being connected to the EMCS).

2.1.2.4 Internal Clock

Provide internal clocks for all BACnet Building Controllers (B-BC) and BACnet Advanced Application Controllers (B-AAC) using BACnet time synchronization services. Automatically synchronize system clocks daily from an operator-designated controller. The system shall automatically adjust for daylight saving time.

2.1.2.5 Memory

Provide sufficient memory for each controller to support the required control, communication, trends, alarms, and messages. Protect programs residing in memory with EEPROM, flash memory, or by an uninterruptible power source (battery or uninterruptible power supply). The backup power source shall have capacity to maintain the memory during a 72-hour continuous power outage. Rechargeable power sources shall be constantly charged while the controller is operating under normal line power. Batteries shall be replaceable without soldering. Trend and alarm history

collected during normal operation shall not be lost during power outages less than 72 hours long.

2.1.2.6 Immunity to Power Fluctuations

Controllers shall operate at 90 percent to 110 percent nominal voltage rating.

2.1.2.7 Transformer

The controller power supply shall be fused or current limiting and rated at 125 percent power consumption.

2.1.2.8 Wiring Terminations

Use screw terminal wiring terminations for all field-installed controllers. Provide field-removable modular terminal strip or a termination card connected by a ribbon cable for all controllers other than terminal units.

2.1.2.9 Input and Output Interface

Provide hard-wired input and output interface for all controllers as follows:

a. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with sources up to 24 volts AC or DC for any duration shall cause no controller damage.

b. Binary Inputs: Binary inputs shall monitor two state devices.

c. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and accumulate pulses at a resolution suitable to the application.

d. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.

e. Binary Outputs: Binary outputs shall have a toggle switch and send a pulsed 24 VDC low-voltage signal for modulation control, or provide a maintained open-closed position for on-off control. For HVAC equipment and plant controllers, provide for manual overrides, either with three-position (on-off-auto) override switches and status lights, or with an adjacent operator display and interface. Where appropriate, provide a method to select normally open or normally closed operation.

f. Analog Outputs: Analog outputs shall send modulating 0-10 VDC or 4-20 mA signals to control output devices.

g. Tri-State Outputs: Tri-State outputs shall provide three-point floating control of terminal unit electronic actuators.

2.1.2.10 Digital Controller Cabinet

Provide each digital controller as factory mounted or in a factory fabricated cabinet enclosure. Cabinets located indoors shall protect against dust and have a minimum NEMA 1 rating, except where indicated otherwise. Cabinets located outdoors or in damp environments shall protect

against all outdoor conditions and have a minimum NEMA 4 rating. Mechanical rooms that contain steam service or equipment are considered damp environments. Outdoor control panels and controllers must be able to withstand extreme ambient conditions, without malfunction or failure, whether or not the controlled equipment is running. If necessary, provide a thermostatically controlled panel heater in freezing locations, and an internal ventilating fan in locations exposed to direct sunlight. Cabinets shall have a hinged lockable door and an offset removable metal back plate, except controllers integral with terminal units, like those mounted on VAV boxes. Provide like-keyed locks for all hinged panels provided and a set of two keys at each panel, with one key inserted in the lock.

2.1.2.11 Main Power Switch and Receptacle

Provide each control cabinet with a main external power on/off switch located inside the cabinet. Also provide each cabinet with a separate 120 VAC duplex receptacle.

2.1.2.12 DSL Modems

DSL modems and Rate Adaptive Asymmetric Digital Subscriber Line (RADSL) modems are provided by the government. Telephone modems are not permitted for any other communication with the DDC system.

2.1.2.13 BACnet Gateways

Provide gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC controlled plant equipment, only when specifically requested and approved by the Government, and shown on the Government approved BACnet Communication Architecture Schematic. Communication shall be MS/TP. Communication using IP is not permitted. Provide with each gateway an interoperability schedule Use gateway interoperability schedules shown on design drawings or other project documents, showing each point or event on the legacy side that the BACnet "client" will read, and each parameter that the BACnet network will write to. Describe this interoperability in terms of BACnet services, or Interoperability Building Blocks (BIBBS), defined in ASHRAE 135 Annex K. Provide two-year minimum warranty for each gateway, including parts and labor.

The following minimum capabilities are required:

a. Gateways shall be able to read and view all readable object properties listed in the interoperability schedule on the non-BACnet network to the BACnet network and vice versa where applicable.

b. Gateways shall be able to write to all writeable object properties listed in the interoperability schedule on the non-BACnet network from the BACnet network and vice versa where applicable.

c. Gateways shall provide single-pass (only one protocol to BACnet without intermediary protocols) translation from the non-BACnet protocol to BACnet and vice versa.

d. Gateways shall meet the requirements of Data Sharing Read Property (DS-RP-B), Data Sharing Write Property (DS-WP-B), Device Management Dynamic Device Binding-B (DM-DDB-B), and Device Management Communication Control (DM-DCC-B) BIBBs, in accordance with ASHRAE 135.

e. Gateways shall include all hardware, software, software licenses, and configuration tools for operator-to-gateway communications. Provide backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.1.3 Notebook Computer

Provide a notebook computer, complete with the project's installed DDC software, configuration files and, applications database, to fully troubleshoot and program the project's devices. Provide the notebook computer with ballistic nylon carrying case with shoulder strap with all necessary cables and interface hardware needed for setup and communication with the controllers and control system components.

At a minimum the notebook computer shall include: Common Access Card reader, a Microsoft XP Professional operating system, processor with capability and speed required by application software, 40 giga-byte hard drive, 512 mega-byte RAM, 2 USB 2.0 ports, 10/100 network interface card, internal V.92 modem, 15-inch display, keyboard, 3-hour battery with charger, 52X internal CD-RW drive with CD creator software, and Microsoft Office bundled software. Provide all original licenses, installation media, documentation, and recovery CDs capable of restoring the original configuration. Provide the manufacturer's 3-year next business day on-site warranty with the Government listed as the warranty owner. Provide a CAC card access port.

2.1.4 DDC Software

2.1.4.1 Programming

Provide programming to execute the sequence of operation indicated. Provide all programming, programming software tools, and programming hardware tools to configure and program all controllers. If the laptop computer provided elsewhere is used as a programming tool, provide all necessary accessories for full functionality. All software shall be licensed to Marine Corps Base, Camp Lejeune Complex for unrestricted use on Camp Lejeune Complex and reproduction for use on Camp Lejeune Complex. Software keys and "dongles" are not permitted. Provide sequence of operation routines in simple, easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to the project's written sequence of operation.

a. Graphic-based programming shall use a library of function blocks made from pre-programmed code designed for BAS control. Function blocks shall be assembled with interconnecting lines, depicting the control sequence in a flowchart. If providing a computer with device programming tools as part of the project, graphic programs shall be viewable in real time showing present values and logical results from each function block.

b. Menu-based programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.

c. For line-by-line and text-based programming, declare variable types (local, global, real, integer, etc.) at the beginning of the program. Use descriptive comments frequently to describe the programming.

d. If providing a computer with device programming tools as part of the project, provide a means for detecting program errors and testing

software strategies with a simulation tool. Simulation may be inherent within the programming software suite, or provided by physical controllers mounted in a NEMA 1 test enclosure. The test enclosure shall contain one dedicated controller of each type provided under this contract, complete with power supply and relevant accessories.

2.1.4.2 Parameter Modification

All writeable object properties, and all other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

2.1.4.3 Short Cycling Prevention

Provide setpoint differentials and minimum on/off times to prevent equipment short cycling.

2.1.4.4 Equipment Status Delay

Provide an adjustable delay from when equipment is commanded on or off and when the control program looks to the status input for confirmation.

2.1.4.5 Run Time Accumulation

Use the Elapsed Time Property to provide re-settable run time accumulation for each Binary Output Object connected to mechanical loads greater than 1 HP, electrical loads greater than 10 KW, or wherever else specified.

2.1.4.6 Timed Local Override

Provide a non-cumulative adjustable override time for the push of a local override button.

2.1.4.7 Time Synchronization

Provide time synchronization, including adjustments for leap years, daylight saving time, and operator time adjustments.

2.1.4.8 Scheduling

Provide operating schedules as indicated, with equipment assigned to groups. Changing the schedule of a group shall change the operating schedule of all equipment in the group. Groups shall be capable of operator creation, modification, and deletion. Provide capability to view and modify schedules in a seven-day week format. Provide capability to enter holiday and override schedules one full year at a time.

2.1.4.9 Object Property Override

Allow writeable object property values to accept overrides to any valid value. Where specified or required for the sequence of control, the Out Of Service property of Objects shall be modifiable using BACnet's write property service. When documented, exceptions to these requirement are allowed for life, machine, and process safeties.

2.1.4.10 Alarms and Events

Alarms and events shall be capable of having programmed time delays and high-low limits. All alarms/events shall report to the EMCS server. Alarms/events shall be stored within the Site Building Controller (SBC). Provide alarms/events in agreement with the point schedule, sequence of operation, and the BAS Owner. At a minimum, provide programming to initiate alarms/events any time a piece of equipment fails to operate, a control point is outside normal range or condition shown on schedules, communication to a device is lost, a device has failed, or a controller has lost its memory.

2.1.4.11 Trending

Provide BACnet trend services capable of trending all object present values set points, and other parameters indicated for trending on project schedules. Trends may be associated into groups, and a trend report may be set up for each group. Trends are stored within a device on the BACnet network, with operator selectable trend intervals from 10 seconds up to 60 minutes. The minimum number of consecutive trend values stored at one time shall be 100 per variable. When trend memory is full, the most recent data shall overwrite the oldest data.

The SBC shall upload trends automatically upon reaching 3/4 of the device buffer limit (via Notification_Threshold property), by operator request, or by time schedule for archiving. Archived and real-time trend data shall be available for viewing numerically and graphically for at the workstation and connected notebook computers.

2.1.4.12 Device Diagnostics

Each controller shall have diagnostic LEDs for power, communication, and device fault condition. The DDC system shall recognize and report a non-responsive controller.

2.1.4.13 Power Loss

Upon restoration of power, the DDC system shall perform an orderly restart and restoration of control.

2.1.4.14 Access Control

Provide at least five levels of password protection for operator interfaces. The lowest level only allowing viewing of graphics. The second level allows viewing graphics and changing space temperature setpoints. The third level allows the previous level's capability, plus changing operating schedules. The fourth level allows access to all functions except passwords. The highest level provides all administrator rights and allows full access to all programming, including setting new passwords and access levels. Provide the BAS Owner with the highest level password access. Provide automatic log out if no keyboard or mouse activity is detected after a user-defined time delay.

2.1.4.15 Configuration Tool

Provide the software with the manufacturer's installation CDs and licenses. Licenses shall allow unrestricted use and reproduction for use at the Camp Lejeune Complex. Software shall not require the use of software keys or "dongles" Configure the software according to the DDC

system manufacturer's specifications and in agreement with BACnet standards found in ASHRAE 135, Annex L.

The software shall permit complete monitoring, modification, and troubleshooting interface with the DDC system. The operator interface with the software shall be menu-driven with appropriate displays and menu commands to manipulate the DDC system's objects, point data, operating schedules, control routines, system configuration, trends, alarms, messages, graphics, and reports. Trends shall be capable of graphic display in real time, with variables plotted as functions of time. Each alarmed point shall be capable of displaying its alarm history, showing when it went into alarm, if and when it was acknowledged, and when it went out of alarm. The modification of DDC system parameters and object properties shall be accomplished with "fill in the blank" and/or "point and drag" methods. Modifications shall download to the appropriate controllers at the operator's request.

2.1.4.16 Graphics Software

Provide web-based system graphics viewable on browsers compatible with MS Internet Explorer 6.X or greater using an industry-standard file format such as HTML, BMP, JPEG, or GIF. Graphics for new projects must be consistent with base standards including layout and device naming. Contractor shall install this graphics package on the EMCS Server, bind all points, and demonstrate operability.

Graphic displays shall have full-screen resolution when viewed on the workstation and notebook computers. Dynamic data on graphics pages shall refresh within 10 seconds using an Internet connection, or 30 seconds using a dial-up modem connection. Graphics viewing shall not require additional "plug-in" software like Java, Shockwave and Flash applications unless the software is readily available for free over the Internet, and certified for use with Navy Marine Corps Internet (NMCI) personal computers.

The graphics shall show the present value and object name for each of the project's I/O points on at least one graphic page. Arrange point values and names on the graphic displays in their appropriate physical locations with respect to the floor plan or equipment graphic displayed. Graphics shall allow the operator to monitor current status, view zone and equipment summaries, use point-and-click navigation between graphic pages, and edit setpoints and parameters directly from the screens. Items in alarm shall be displayed using a different color or other obvious visual indicator. Provide graphics with the following:

a. Graphic Types: Provide at least one graphic display for each piece of HVAC equipment, building floor, and controlled zone. Indicate dynamic point values, operating statuses, alarm conditions, and control setpoints on each display. Provide summary pages where appropriate.

    (1) Building Floor Plans: Provide a floor plan graphic for each of the building's floors and roof with dynamic display of space temperature and other important data. If used, indicate and provide links to sub-plan areas. If possible, use the project's electronic drawing files for the graphic backgrounds. Provide clear names for important areas, such as "Main Conference Room." Include room names and numbers where applicable. Include features such as stairwells, elevators, and main entrances. Where applicable, include the mechanical room, HVAC equipment, and control component locations, with corresponding links to the

equipment graphics.

(2) Sub-plan Areas: Where a building's floor plan is too large to adequately display on the screen, sub-divide the plan into distinct areas, and provide a separate graphic display for each area. Provide same level of detail requested in building floor plan section above.

(3) HVAC Equipment: Provide a graphic display for each piece of HVAC equipment, such as a fan coil unit, VAV terminal, or air handling unit. Equipment shall be represented by a two or three-dimensional drawing. Where multiple pieces of equipment combine to form a system, such as a central chiller plant or central heating plant, provide one graphic to depict the entire plant. Indicate the equipment, piping, ductwork, dampers, and control valves in the installed location. Include labels for equipment, piping, ductwork, dampers, and control valves. Show the direction of air and water flow. Include dynamic display of applicable object data with clear names in appropriate locations.

(4) Sequence of Operation: Provide a graphic screen displaying the written out full sequence of operation for each piece of HVAC equipment. Provide a link to the sequence of operation displays on their respective equipment graphics. Include dynamic real-time data within the text for setpoints and variables.

b. Graphic Title: Provide a prominent, descriptive title on each graphic page.

c. Dynamic Update: When the workstation is on-line, all graphic I/O object values shall update with change-of-value services, or by operator selected discrete intervals.

d. Graphic Linking: Provide forward and backward linking between floor plans, sub-plans, and equipment.

e. Graphic Editing: Provide installed software to create, modify, and delete the DDC graphics. Include the ability to store graphic symbols in a symbol directory and import these symbols into the graphics.

f. Dynamic Point Editing: Provide full editing capability for deleting, adding, and modifying dynamic points on the graphics.

2.2 SENSORS AND INPUT HARDWARE

Coordinate sensor types with the BAS Owner to keep them consistent with existing installations.

2.2.1 Field-Installed Temperature Sensors

Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary.

2.2.1.1 Thermistors

Precision thermistors may be used in applications below 200 degrees F. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degrees F cumulative. A/D conversion

resolution error shall be kept to 0.1 degrees F. Total error for a thermistor circuit shall not exceed 0.5 degrees F.

2.2.1.2 Resistance Temperature Detectors (RTDs)

Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degrees F cumulative. Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degrees F. Allow an additional 0.5 percent accuracy for averaging sensors.

2.2.1.3 Temperature Sensor Details

a. Room Type: Provide the sensing element components within a decorative protective cover suitable for surrounding decor. Provide room temperature sensors with timed override button, setpoint adjustment lever, digital temperature display. Provide a communication port for a portable operator interface like a notebook computer or PDA.

b. Duct Probe Type: Ensure the probe is long enough to properly sense the air stream temperature.

c. Duct Averaging Type: Continuous averaging sensors shall be one foot in length for each 4 square feet of duct cross-sectional area, and a minimum length of 6 feet.

d. Pipe Immersion Type: Provide minimum three-inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel when used in steel piping, and brass when used in copper piping. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior.

e. Outside Air Type: Provide the sensing element on the building's north side with a protective weather shade that positions the sensor approximately 3 inches off the wall surface, does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain.

2.2.2 Transmitters

Provide transmitters with 4 to 20 mA or 0 to 10 VDC linear output scaled to the sensed input. Transmitters shall be matched to the respective sensor, factory calibrated, and sealed. Size transmitters for an output near 50 percent of its full-scale range at normal operating conditions. The total transmitter error shall not exceed 0.1 percent at any point across the measured span. Supply voltage shall be 12 to 24 volts AC or DC. Transmitters shall have non-interactive offset and span adjustments. For temperature sensing, transmitter drift shall not exceed 0.03 degrees F a year.

2.2.2.1 Pressure Transmitters

Provide transmitters integral with the pressure transducer.

2.2.3 Current Transducers

Provide current transducers to monitor motor amperage. Current switches may be used to indicate on/off status.

2.2.4 Air Quality Sensors

Provide power supply for each sensor.

2.2.4.1 CO2 Sensors

Provide photo-acoustic type CO2 sensors with integral transducers and linear output. The devices shall read CO2 concentrations between 0 and 2000 ppm with full scale accuracy of at least plus or minus 100 ppm.

2.2.4.2 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based on the Taguchi principle. The sensor shall monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor shall automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 32 to 140 degrees F and 5 to 95 percent relative humidity.

2.2.5 Input Switches

2.2.5.1 Timed Local Overrides

Provide buttons or switches to override the DDC occupancy schedule programming for each major building zone during unoccupied periods, and to return HVAC equipment to the occupied mode. This requirement is waived for zones clearly intended for 24 hour continuous operation.

2.2.6 Freeze Protection Thermostats

Provide special purpose thermostats with flexible capillary elements 20 feet in length for coil face areas up to 40 square feet. Provide additional thermostats for larger coils. Provide switch contacts rated for the respective motor starter's control circuit voltage. Include auxiliary contacts for the switch's status condition. A freezing condition at any 18-inch increment along the sensing element's length shall activate the switch. The thermostat shall be equipped with a manual push-button reset switch so that when tripped, the thermostat requires manual resetting before the HVAC equipment can restart.

2.2.7 Air Flow Measurement Stations

Air flow measurement stations shall have an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements shall be the RTD or thermistor type, traversing the ducted air in at least two directions. The air flow pressure drop across the station shall not exceed 0.1 inch water gage at a velocity of 2,000 fpm. The station shall be suitable for air flows up to 2500 fpm, and a temperature range of 0 to 140 degrees F. The station's measurement accuracy over the range of 125 to 2,500 fpm shall be plus or minus 3 percent of the measured velocity. Station transmitters shall provide a

linear, temperature-compensated 4 to 20 mA or 0 to 10 VDC output. The output shall be capable of being accurately converted to a corresponding air flow rate in cubic feet per minute. Transmitters shall be a 2-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the measurement.

2.2.8 Air Flow Measurement For Terminal Devices

Air flow measurement for terminal devices such as variable air volume boxes, with or without fan power shall have an array of pressure sensing elements that sense total pressure and static pressure. The flow measurement shall be integral to the device controller and shall be by differential pressure sensor. The air flow shall measure flows down to 300 fpm with an accuracy of 5 percent of reading.

2.3 OUTPUT HARDWARE

2.3.1 Control Dampers

Provide factory manufactured aluminum blade/galvanized steel frame dampers where indicated. Control dampers shall comply with SMACNA 1966 except as modified or supplemented by this specification. Published damper leakage rates and respective pressure drops shall have been verified by tests in compliance with AMCA 500-D requirements.

Provide damper assembly frames constructed of 13 gauge minimum thickness galvanized steel channels with mitered and welded corners. Damper axles shall be 0.5 inches minimum diameter plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings.

Dampers shall be rated for not less than 2000 fpm air velocity. The pressure drop through each damper when full-open shall not exceed 0.04 inches water gage at 1000 fpm face velocity. Damper assemblies in ductwork subject to above 3-inch water gauge static air pressure shall be constructed to meet SMACNA Seal Class "A" construction requirements.

Provide the damper operating linkages outside of the air stream, including crank arms, connecting rods, and other hardware that transmits motion from the damper actuators to the dampers, shall be adjustable. Additionally, operating linkages shall be designed and constructed to have a 2 to 1 safety factor when loaded with the maximum required damper operating force. Linkages shall be brass, bronze, galvanized steel, or stainless steel.

Provide access doors or panels in hard ceilings and walls for access to all concealed damper operators and damper locking setscrews.

For field-installed control dampers, a single damper section shall have blades no longer than 48 inches and no higher than 72 inches. The maximum damper blade width shall be 12 inches. Larger sized dampers shall be built using a combination of sections.

Frames shall be at least 2 inches wide. Flat blades shall have edges folded for rigidity. Blades shall be provided with compressible gasket seals along the full length of the blades to prevent air leakage when closed.

The damper frames shall be provided with jamb seals to minimize air leakage. Seals shall be suitable for an operating temperature range of minus 40 degrees F to 200 degrees F.

The leakage rate of each damper when full-closed shall be no more than 2 cfm per sq. foot of damper face area at 1.0 inches water gage static pressure.

2.3.2 Control Valves

2.3.2.1 Valve Assembly

Valve bodies shall be designed for 125 psig minimum working pressure or 150 percent of the operating pressure, whichever is greater. Valve stems shall be Type 300 series stainless steel. Valve leakage ratings shall be 0.01 percent of rated Cv value. Class 125 copper alloy valve bodies and Class 150 steel or stainless steel valves shall meet the requirements of ASME B16.5. Cast iron valve components shall meet the requirements of ASTM A 126 Class B or C.

2.3.2.2 Butterfly Valves

Butterfly valves shall be the threaded lug type suitable for dead-end service and for modulation to the fully-closed position, with stainless steel shafts supported by bearings, non-corrosive discs geometrically interlocked with or bolted to the shaft (no pins), and EPDM seats suitable for temperatures from minus 20 degrees F to plus 250 degrees F. Valves shall have a means of manual operation independent of the actuator.

2.3.2.3 Three-Way Valves

Three-way valves shall have an equal percentage characteristic.

2.3.2.4 Valves for Chilled Water, Condenser Water, and Glycol Fluid Service

a. Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for 2 inch valves shall have threaded connections. Bodies for valves from 2-1/2 to 3 inches shall have flanged connections.

b. Internal valve trim shall be brass or bronze, except that valve stems shall be stainless steel.

c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

d. Valves 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.5 Valves for Hot Water Service

Valves for hot water service below 250 Degrees F:

a. Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for 2 inch valves shall have threaded connections. Bodies for valves from 2-1/2 to 3 inches shall have flanged connections.

b. Internal trim (including seats, seat rings, modulation plugs, valve

stems, and springs) of valves controlling water above 210 degrees F shall be Type 300 series stainless steel.

c. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Valve stems shall be Type 300 series stainless steel.

d. Non-metallic parts of hot water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.

e. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

f. Valves 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.6 Valves for High Temperature Hot Water Service

Valves for hot water service 250 Degrees F above:

a. Valve bodies shall conform to ASME B16.34 Class 300. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 1 inch and larger. Valves smaller than 1 inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE).

b. Internal valve trim shall be Type 300 series stainless steel.

c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

2.3.3 Actuators

Provide direct-drive electric actuators for all control applications, except where indicated otherwise.

2.3.3.1 Electric Actuators

Each actuator shall deliver the torque required for continuous uniform motion and shall have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators shall function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds. Provide two-position actuators of single direction, spring return, or reversing type. Provide modulating actuators capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators shall be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Actuators without spring-return may only be used on terminal fan coil units, terminal VAV units, convectors, and unit heaters. Spring return actuators shall be provided on all control dampers and all control valves except terminal fan coil units, terminal VAV units, convectors, and unit heaters; unless indicated otherwise. Each actuator shall have distinct markings indicating the full-open and full-closed

position, and the points in-between.

2.3.4 Output Signal Conversion

2.3.5 Output Switches

2.3.5.1 Control Relays

Field installed and DDC panel relays shall be double pole, double throw, UL listed, with contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without tools or removing wiring. Encapsulated "PAM" type relays may be used for terminal control applications.

2.4 ELECTRICAL POWER AND DISTRIBUTION

2.4.1 Transformers

Transformers shall conform to UL 506. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.

2.4.2 Surge and Transient Protection

Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.

2.4.2.1 Power Line Surge Protection

Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:

a. The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.

b. The device shall react within 5 nanoseconds and automatically reset.

c. The voltage protection threshold, line to neutral, shall be no more than 211 volts.

d. The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.

e. The primary suppression system components shall be pure silicon avalanche diodes.

f. The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.

g. The device shall have an indication light to indicate the protection components are functioning.

h. All system functions of the transient suppression system shall be

individually fused and not short circuit the AC power line at any time.

i. The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.

j. The device shall comply with IEEE C62.41.1 and IEEE C62.41.2, Class "B" requirements and be tested according to IEEE C62.45.

k. The device shall be capable of operating between minus 20 degrees F and plus 122 degrees F.

2.4.3 Wiring

Provide complete electrical wiring for the DDC System, including wiring to transformer primaries. Unless indicated otherwise, provide all normally visible or otherwise exposed wiring in conduit. Where conduit is required, control circuit wiring shall not run in the same conduit as power wiring over 100 volts. Circuits operating at more than 100 volts shall be in accordance with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Run all circuits over 100 volts in conduit, metallic tubing, covered metal raceways, or armored cable. Use plenum-rated cable for circuits under 100 volts in concealed accessible spaces. Examples of these spaces include HVAC plenums, within walls, above suspended ceilings, in attics, and within ductwork. All wiring in mechanical rooms and mezzanines shall be run in conduit.

2.4.3.1 Power Wiring

The following requirements are for field-installed wiring:

a. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.

b. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.

2.4.3.2 Analog Signal Wiring

Field-installed analog signal wiring shall be in accordance with manufacturer's installation instructions. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.

2.5 FIRE PROTECTION DEVICES

2.5.1 Duct Smoke Detectors

Provide duct smoke detectors in HVAC ducts in accordance with NFPA 72 and NFPA 90A, except as indicated otherwise. Provide UL listed or FM approved detectors, designed specifically for duct installation.

Provide photoelectric type detectors. Detectors shall detect both visible and invisible particles of combustion, and shall not be susceptible to undesired operation by changes to relative humidity. Provide each detector with an approved duct housing mounted exterior to the duct, and an integral perforated sampling tube extending across the width of the duct. The

detector housing shall have indicator lamps that light when the detector is powered and when the detector is activated. Each detector shall have an integral test port and test switch. Connect new detectors to the building's existing fire alarm control panel. Provide control and power modules required for the operation of the detectors in their own new control unit or integral with the existing fire alarm panel. A ground fault, break, or open condition in the electrical circuitry to any detector or its control or power unit shall cause activation of a trouble signal at the building fire alarm panel. Electrical supervision of wiring used exclusively for air-handling unit shutdown is not required, provided a break in the wiring would cause shutdown of the associated unit. Equipment and devices shall be compatible and operable in all respects with, and shall in no way impair the reliability or operational functions of, the existing fire alarm system. The building's existing fire alarm control panel was manufactured by Johnson Controls. Provide descriptive zone labels at the existing fire alarm panel indicating which new air-handling unit detectors they serve and their location. Label zones modified in order to accomplish the work.

Provide smoke control systems with a provision for manual operation by means of a key-operated switch to override the duct smoke detector shutdowns. Locate the override switch adjacent to the building's fire alarm system control panelas indicated.

2.6 VARIABLE FREQUENCY (MOTOR) DRIVES

Provide variable frequency drives (VFDs) as indicated. VFDs shall convert 240 or 460 volt (plus or minus 10 percent), three phase, 60 hertz (plus or minus 2Hz), utility grade power to adjustable voltage/frequency, three phase, AC power for stepless motor control from 5 percent to 105 percent of base speed. VFDs shall be UL listed as delivered to the end user. The VFD shall meet the requirements specified in the most current National Electrical Code. Each VFD shall also meet the following:

a. The VFD shall use sine coded Pulse Width Modulation (PWM) technology. PWM calculations shall be performed by the VFD microprocessor.

b. The VFD shall be capable of automatic control by a remote 4-20 mA 0 to 10 VDC signal, BACnet interface, or manually by the VFD control panel.

2.6.1 VFD Quality Assurance

VFDs shall be the manufacturer's current standard production unit with at least 10 identical units successfully operating in the field.

2.6.2 VFD Service Support

a. Warranty: Provide the VFDs with a minimum 24-month full parts and labor warranty. The warranty shall start when the contract's HVAC system is accepted by the Government. Include warranty documentation, dates, and contact information with the VFD on-site service manuals.

b. VFD Service Manuals: Provide the VFDs with all necessary installation, operation, maintenance, troubleshooting, service, and repair manuals in English including related factory technical bulletins. Provide the documents factory bound, in sturdy 3-ring binders, or hard bound covers. Provide a title sheet on the outside of each binder indicating

the project title, project location, installing contractor, contract number, and the VFD manufacturer, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. The documentation provided shall be specifically applicable to this project, shall be annotated to reflect the actual project conditions, and shall provide a complete and concise depiction of the installed work. Provide a storage cabinet on or near the VFD large enough to hold all of the documentation. Have the cabinet's proposed installation site approved in advance by the Contracting Officer. Prominently label the cabinet "VFD OPERATION AND MAINTENANCE MANUALS." Clearly label each manual with the wording "MECHANICAL ROOM COPY - DO NOT REMOVE".

c. Technical Support: Provide the VFDs with manufacturer's technical telephone support in English, readily available during normal working hours, and free of charge for the life of the equipment.

d. Initial Start-Up: Provide the VFDs with factory-trained personnel for the on-site start-up of the HVAC equipment and associated VFD. The personnel shall be competent in the complete start-up, operation, and repair of the particular model VFD installed. The factory start-up representative shall perform the factory's complete recommended start-up procedures and check-out tests on the VFD. Include a copy of the start-up test documentation with the VFD on-site service manuals.

e. Provide the VFDs with on-site/hands-on training for the user and maintenance personnel. Provide a capable and qualified instructor with minimum two years field experience with the operation and maintenance of similar VFDs. The training shall occur during normal working hours and last not less than 2 hours. Coordinate the training time with the Contracting Officer and the end user. The VFD service manuals shall be used during the training. The contractor shall ensure the manuals are on-site before the start of training. The training shall cover all operational aspects of the VFD.

2.6.3 VFD Features

VFDs shall have the following features:

a. A local operator control keypad capable of:

(1) Remote/Local operator selection with password access.

(2) Run/Stop and manual speed commands.

(3) All programming functions.

(4) Scrolling through all display functions.

b. Digital display capable of indicating:

(1) VFD status.

(2) Frequency.

(3) Motor RPM.

(4) Phase current.

(5) Fault diagnostics in descriptive text.

(6) All programmed parameters.

c. Standard PI loop controller with input terminal for controlled variable and parameter settings.

d. User interface terminals for remote control of VFD speed, speed feedback, and an isolated form C SPDT relay, which energizes on a drive fault condition.

e. An isolated form C SPDT auxiliary relay which energizes on a run command.

f. A metal NEMA 1 enclosure for indoors, NEMA 4 with heater for outdoors.

g. An adjustable carrier frequency with 16 KHz minimum upper limit.

h. A built in or external line reactor with 3 percent minimum impedance to protect the VFDs DC buss capacitors and rectifier section diodes.

2.6.4 Programmable Parameters

VFDs shall include the following operator programmable parameters:

a. Upper and lower limit frequency.

b. Acceleration and Deceleration rate.

c. Variable torque volts per Hertz curve.

d. Starting voltage level.

e. Starting frequency level.

f. Display speed scaling.

g. Enable/disable auto-restart feature.

h. Enable/disable soft stall feature.

i. Motor overload level.

j. Motor stall level.

k. Jump frequency and hysteresis band.

l. PWM carrier frequency.

2.6.5 Protective Features

VFDs shall have the following protective features:

a. An electronic adjustable inverse time current limit with consideration for additional heating of the motor at frequencies below 45Hz, for the protection of the motor.

b. An electronic adjustable soft stall feature, allowing the VFD to lower the frequency to a point where the motor will not exceed the full-load

amperage when an overload condition exists at the requested frequency. The VFD will automatically return to the requested frequency when load conditions permit.

c. A separate electronic stall at 110 percent VFD rated current, and a separate hardware trip at 190 percent current.

d. Ground fault protection that protects the output cables and motor from grounds during both starting and continuous running conditions.

e. The ability to restart after the following faults:

(1) Overcurrent (drive or motor).

(2) Power outage.

(3) Phase loss.

(4) Over voltage/Under voltage.

f. The ability shut down if inadvertently started into a rotating load without damaging the VFD or the motor.

g. The ability to keep a log of a minimum of four previous fault conditions, indicating the fault type and time of occurrence in descriptive text.

h. The ability to sustain 110 percent rated current for 60 seconds

i. The ability to shutdown safely or protect against and record the following fault conditions:

(1) Over current (and an indication if the over current was during acceleration, deceleration, or running).

(2) Over current internal to the drive.

(3) Motor overload at start-up.

(4) Over voltage from utility power.

(5) Motor running overload.

(6) Over voltage during deceleration.

(7) VFD over heat.

(8) Load end ground fault.

(9) Abnormal parameters or data in VFD EEPROM.

2.6.6 Minimum Operating Conditions

VFDs shall be designed and constructed to operate within the following service conditions:

a. Ambient Temperature Range, 0 to 120 degrees F.

b. Non-condensing relative humidity to 90 percent.

2.6.7 Additional Features

Provide VFDs with the following additional features:

a. BACnet MS/TP communication interface port

b. RFI/EMI filters

c. One spare VFD of each model provided, fully programmed and ready for back-up operation when connected.

PART 3 EXECUTION

3.1 INSTALLATION

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1 BACnet Naming and Addressing

Coordinate with the EMCS Owner and provide naming and addressing consistent with existing buildings already loaded on the EMCS server. All DDC controllers shall have a Camp Lejeune unique instance number and all Site Building Controllers shall have a Camp Lejeuene unique name.

a. MAC Address

Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For ARCNET or MS/TP, assign from 4 to 128.

b. Network Numbering

Assign unique numbers to each new network installed on the BACnet internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.

c. Device Object Identifier Property Number

Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.

d. Device Object Name Property Text

The Device Object Name property field shall support 32 minimum printable characters. Assign unique Device "Object_Name" property names with plain-English descriptive names for each device
For example, the Device Object Name for the device controlling the first floor air handler unit at Building AS4035 would be:

Name=Air Station.AS4035.First Floor.Air Handling Unit.AHU-1-A

e. Object Name Property Text (Other than Device Objects)

The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

f. Object Identifier Property Number (Other than Device Objects)

Assign Object Identifier property numbers according to design drawings or tables if provided. If not provided, Object Identifier property numbers may be assigned at the Contractor's discretion but must be approved by the Government. In this case they must be documented and unique for like object types within the device.

3.1.2 Minimum BACnet Object Requirements

a. Use of Standard BACnet Objects in accordance with existing Camp Lejeune standards

For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service:
all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.

b. BACnet Object Description Property

The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.

c. Analog Input, Output, and Value Objects

Support and provide Description and/or Device_Type text strings matching signal type and engineering units shown on the points list.

d. Binary Input, Output, and Value Objects

Support and provide Inactive_Text and Active_Text property descriptions matching conditions shown on the points list.

e. Calendar Object

For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. All operators may view Calendar Objects; authorized operators may make modifications from a workstation. Enable the writeable Date List property and support all calendar entry data types.

f. Schedule Object

Use Schedule Objects for all building system scheduling. All operators may view schedule entries; authorized operators may modify schedules

from a workstation.

g. Loop Object or Equal

Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint, Proportional Constant, Integral Constant, and Derivative Constant using BACnet read/write services.

3.1.3 Minimum BACnet Service Requirements

a. Command Priorities

Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below. If the sequence of operation requires a different priority, obtain approval from the Contracting Officer.

Priority Level	Application
1	Manual-Life Safety
2	Automatic-Life Safety
3	(User Defined)
4	(User Defined)
5	Critical Equipment Control
6	Minimum On/Off
7	(User Defined)
8	Manual Operator
9	(User Defined)
10	(User Defined)
11	Load Shedding
12	(User Defined)
13	(User Defined)
14	(User Defined)
15	(User Defined)
16	(User Defined)

b. Alarming

(1) Alarm Priorities - Coordinate alarm and event notification with the BAS Owner.

(2) Notification Class - Enable writeable Priority, Ack Required, and Recipient List properties of Notification Class objects.

(3) Event Notification Message Texts - Use condition specific narrative text and numerical references for alarm and event notification.

c. Updating Displayed Property Values

Allow workstations to display property values at discrete polled intervals, or based on receipt of confirmed and unconfirmed Change of Value notifications. The COV increment shall be adjustable by an operator using BACnet services, and polled intervals shall be adjustable at the operator workstation.

3.1.4 Local Area Networks

Obtain Government approval before connecting new networks with existing networks. Network numbers and device instance numbers shall remain unique when joining networks. Do not change existing network addressing without Government approval. See also "BACnet Naming and Addressing".

3.1.5 BACnet Routers, Bridges, and Switches

Provide the quantity of BACnet routers, bridges, and switches necessary for communications shown on the BACnet Communication Architecture schematic. Provide BACnet routers with BACnet Broadcast Message Device (BBMD) capability on each BACnet internetwork communicating across an MS/TP network. Configure each BACnet device and bridge, router, or switch to communicate on its network segment. All switches provided by the contractor shal lbe approved by base telephone.

3.1.6 Wiring Criteria

a. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.

b. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.

c. Provide circuit and wiring protection required by NFPA 70.

d. Run all wiring located inside mechanical rooms in conduit.

e. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.

f. Input/output identification: Permanently label each field-installed wire, cable, and pneumatic tube at each end with descriptive text using a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Number each pneumatic tube every six feet. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.

g. For controller power, provide new 120 VAC circuits, with ground, if not defined on the electrical drawings. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.

h. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.

i. Grounding: Ground controllers and cabinets to a good earth ground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.

j. The Contractor shall be responsible for correcting all associated ground loop problems.

k. Run wiring in panel enclosures in covered wire track.

3.1.7 Accessibility

Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install digital controllers, data ports, and concealed actuators, valves, dampers, and like equipment in locations freely accessible through access doors.

3.1.8 Digital Controllers

a. Install as stand alone control devices (see definitions).

b. Locate control cabinets at the locations shown on the drawings. If not shown on the drawings, install in the most accessible space, close to the controlled equipment.

3.1.9 Hand-Off-Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.10 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.

3.1.10.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of the sensor at the heightindicated.

3.1.10.2 Duct Temperature Sensors

a. Probe Type: Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. Seal the duct insulation penetration vapor tight.

b. Averaging Type (and coil freeze protection thermostats): Weave the capillary tube sensing element in a serpentine fashion perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports. Prevent contact between the capillary and the duct or air handler internals. Provide a duct access door at the sensor location. The access door shall be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors shall be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.10.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermal conductivity material within the well to fully coat the inserted sensor.

3.1.10.4 Outside Air Temperature Sensors

Provide outside air temperature sensors in weatherproof enclosures on the north side of the building, away from exhaust hoods and other areas that may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.11 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous and accumulated energy usage.

3.1.12 Damper Actuators

Where possible, mount actuators outside the air stream in accessible areas.

3.1.13 Thermometers and Gages

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.14 Pressure Sensors

Locate pressure sensors as indicated.

3.1.15 Component Identification Labeling

Using an electronic hand-held label maker with white tape and bold black block lettering, provide an identification label on the exterior of each new control panel, control device, actuator, and sensor. Also provide labels on the exterior of each new control actuator indicating the (full) open and (full) closed positions. For labels located outdoors, use exterior grade label tape, and provide labels on both the inside and outside of the panel door or device cover. Acceptable alternatives are white plastic labels with engraved bold black block lettering permanently attached to the control panel, control device, actuator, and sensor. Have the labels and wording approved by the BAS Owner prior to installation.

3.1.16 Network and Telephone Communication Lines

When telephone lines or network connections by the Government are required, provide the Contracting Officer at least 60 days advance notice of need. Provide 1 inch conduit and Cat 5 cable from the Supervisory Building controller (SBC) to the network connection (most likely in the telephone equipment room).

3.2 INTERFACE WITH EXISTING EMCS

Interface the new DDC system with Camp Lejeune's existing EMCS. Obtain Government approval before connecting new DDC system to the EMCS. Any device connected directly to the EMCS must be approved by the Designated Approving Authority by following procedures listed in the DIACAP instruction. Complete installation and programming includes graphic creation, scheduling, alarming, lard management scheduling and trending. The server is located in Building 24: workstations are located at Buildings 1005, 1023, and 1202. Only Johnson Controls factory trained technicians, approved by the EMCS Engineer will be allowed to program the EMCS.

3.3 TEST AND BALANCE SUPPORT

The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel specified under Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. This support shall include:

a. On-site operation and manipulation of control systems during the testing and balancing.

b. Control setpoint adjustments for balancing all relevant mechanical systems, including VAV boxes.

c. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.4 CONTROLS SYSTEM OPERATORS MANUALS

Provide five electronic and three printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.

Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Government, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.

Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

a. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications.

b. A copy of the project's mechanical design drawings, including any official modifications and revisions.

c. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."

d. A copy of the project's approved Performance Verification Testing Plan and Report. Test report shall be a 48 hour trend report verifying all temperature setpoints listed in the sequence of operation. The trend report should be printed from the EMCS server. All systems (AHU's, ERV's, CHWS, HWS) should be part of this section.

e. A copy of the project's approved final TAB Report. (Added by the Mechancical Contractor (Division 23)).

f. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.

g. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.

h. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.

i. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and notebook, and programming manuals for the workstation and notebook software.

j. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.

k. A written statement entitled "Technical Support" stating the control system manufacturer or authorized representative will provide toll-free telephone technical support at no additional cost to the Government for a minimum of two years from project acceptance, will be furnished by experienced service technicians, and will be available during normal weekday working hours. Include the toll-free technical support telephone number.

l. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Government for a minimum of two years from contract acceptance. Include a table of all DDC system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

3.4.1 Storage Cabinets

In one project mechanical room, provide a wall-mounted metal storage cabinet with hinged doors. Provide cabinets large enough to hold the entire set of Controls System Operators Manuals, and the HVAC operation and maintenance manuals provided under Division 23 HVAC. Locate cabinets adjacent to DDC control panels where applicable. Have each cabinet's proposed installation site approved in advance by the Contracting Officer and the BAS Owner. Prominently label each cabinet with the wording "OPERATION AND MAINTENANCE MANUALS." Place one of the three hard copies of the Operators Manual in this cabinet. Prominently label each binder with

the wording "MECHANICAL ROOM COPY - DO NOT REMOVE."

3.5 PERFORMANCE VERIFICATION TESTING (PVT)

3.5.1 General

The PVT shall demonstrate compliance of the control system work with the contract requirements. The PVT shall be performed by the Contractor and witnessed and approved by the Government. If the project is phased, provide separate testing for each phase. A Pre-PVT meeting to review the Pre-PVT Checklist is required to coordinate all aspects of the PVT and shall include the Contractor's QA representative, the Contractor's PVT administrator, the Contracting Officer's representative, and the EMCS Owner.

3.5.2 Performance Verification Testing Plan

Submit a detailed PVT Plan of the proposed testing for Government approval. Develop the PVT Plan specifically for the control system in this contract. The PVT Plan shall be a clear list of test items arranged in a logical sequence. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested.

The plan shall clearly describe how each item is tested, indicate where assisting personnel are required (like the mechanical contractor), and include what procedures are used to simulate conditions. Include a separate column for each checked item and extra space for comments. Where sequences of operations are checked, insert each corresponding routine from the project’s sequence of operation. For each test area, include signature and date lines for the Contractor's PVT administrator, the Contractor's QA representative, the Contracting Officer's representative, and the EMCS Owner to acknowledge successful completion.

3.5.3 PVT Sample Size

Test all central plant equipment, primary air handling unit controllers, and fan coil unit controllers unless otherwise directed. Use the DDC system to verify all VAV boxes are controlling as specified. The Government may require testing of like controllers beyond a statistical sample if sample controllers require retesting or do not have consistent results.

The Government may witness all testing, or random samples of PVT items. When only random samples are witnessed, the Government may choose which ones.

3.5.4 Pre-Performance Verification Testing Checklist

Submit the following as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.

a. Verify all required mechanical installation work is successfully completed, and all HVAC equipment is working correctly (or will be by the time the PVT is conducted).

b. Verify HVAC motors operate below full-load amperage ratings.

c. Verify all required control system components, wiring, and accessories are installed.

d. Verify the installed control system architecture matches approved drawings.

e. Verify all control circuits operate at the proper voltage and are free from grounds or faults.

f. Verify all required surge protection is installed.

g. Verify the A/C Power Table specified in "CONTROLS SYSTEM OPERATORS MANUALS" is accurate.

h. Verify all DDC network communications with the EMCS function properly, including commanding set points, and load shedding.

i. Verify air handling unit and VAV box coil performance by commanding all valves 100 percent open in both heating and cooling. Record the entering and leaving air temperatures. Record the entering water temperature. This data shall be printed, stored, and saved for future reference.

j. Verify each digital controller’s programming is backed up.

k. Verify all wiring, components, and panels are properly labeled.

l. Verify all required points are programmed into devices.

m. Verify all TAB work affecting controls is complete.

n. Verify all valve and actuator zero and span adjustments are set properly.

o. Verify all sensor readings are accurate and calibrated.

p. Verify each control valve and actuator goes to normal position upon loss of power.

q. Provide 48 hours of trend data to verify all systems are functioning as specified. Trend reports will verify control set point adjustment per the temperature re-set schedules (as required by sequence of operation).

Provide the following Trends:

(1) Chilled water System: supply temperature (actual), return temperature (actual)

(2) Hot Water System: supply temperature (actual), return temperature (actual), supply temperature set point.

(3) Air Handling Unit: discharge air temperature set point, return air temperature set point, discharge air temperature (actual), return air temperature (actual), valve command position.

(4) VAV Box (10 percent of VAV's): room temperature set point, room temperature (actual), associated AHU discharge air temperature (actual).

r. Verify each controller works properly in stand-alone mode.

s. Verify all safety controls and devices function properly, including freeze protection and interfaces with building fire alarm systems.

t. Verify all electrical interlocks work properly.

u. Verify all workstations, notebooks and maintenance personnel interface tools are delivered, all system and database software is installed, and graphic pages are created for each device controlled by the DDC system.

v. Verify the as-built (shop) control drawings are completed.

w. Verify all required alarms are identified at the EMCS server and proper notification is setup for each alarm condition.

3.5.5 Conducting Performance Verification Testing

a. Provide trend report for each HVAC system that is part of the buildings DDC system. The trend report shall include a value for each set point listed in the sequence of operation.

b. Identify any values that do not meet the sequence of operation requirements, make repairs (re-program) and run a new trend for the system. Document each deficiency and corrective action taken.

c. If re-testing is required, follow the procedures for the initial PVT. The Government may require re-testing of any control system components affected by the original failed test.

3.5.6 Controller Capability and Labeling

Test the following for each controller:

a. Memory: Demonstrate that programmed data, parameters, and trend/ alarm history collected during normal operation is not lost during power failure.

b. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a portable electronic device like a notebook computer or PDA. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.

c. Stand Alone Ability: Demonstrate controllers provide stable and reliable stand-alone operation using default values or other method for values normally read over the network. Building DDC system shall function to the project's specifications if connection to the EMCS server is lost.

d. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.

e. Nameplates and Tags: Show the nameplates and tags are accurate and

permanently attached to control panel doors, devices, sensors, and actuators.

3.5.7 EMCS Server Operation

a. Show points lists agree with naming conventions.

b. Show that graphics are complete.

c. Show the UPS operates as specified.

3.5.8 BACnet Communications and Interoperability at the EMCS Server

Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. If available or required in this specification, use a BACnet protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:

a. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.

b. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.

c. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.

d. Peer-to-Peer Data Exchange: Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.

e. Alarm and Event Management: Show that alarms/events are installed and prioritized according to the BAS Owner. Demonstrate time delays and other logic is set up to avoid nuisance tripping, e.g., no status alarms during unoccupied times or high supply air during cold morning start-up. Show that operators with sufficient privilege can read and write alarm/event parameters for all standard BACnet event types. Show that operators with sufficient privilege can change routing (BACnet notification classes) for each alarm/event including the destination, priority, day of week, time of day, and the type of transition involved (TO-OFF NORMAL, TO-NORMAL, etc.).

f. Schedule Lists: Show that schedules are configured for start/stop, mode change, occupant overrides, and night setback as defined in the sequence of operations.

g. Schedule Display and Modification: Show the ability to display any schedule with start and stop times for the calendar year. Show that all calendar entries and schedules are modifiable from any connected workstation by an operator with sufficient privilege.

h. Archival Storage of Data: Show that data archiving is handled by the operator workstation/server, and local trend archiving and display is

accomplished with BACnet Trend Log objects.

i. Modification of Trend Log Object Parameters: Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.

j. Device and Network Management: Show the following capabilities:

(1) Display of Device Status Information

(2) Display of BACnet Object Information

(3) Silencing Devices that are Transmitting Erroneous Data

(4) Time Synchronization

(5) Remote Device Reinitialization

(6) Backup and Restore Device Programming and Master Database(s)

(7) Configuration Management of Half-Routers, Routers and BBMDs

(8) Demonstrate load shed operations if commanded by the EMCS.

3.5.9 Execution of Sequence of Operation

Demonstrate that the HVAC system operates properly through the complete sequence of operation. Use read/write property services to globally read and modify parameters over the internetwork.

3.5.10 Control Loop Stability and Accuracy

For all control loops tested, give the Government trend graphs of the control variable over time, demonstrating that the control loop responds to a 20 percent sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20 percent set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.

3.5.11 Performance Verification Testing Report

Upon successful completion of the PVT, submit a PVT Report to the Government and prior to the Government taking use and possession of the facility. Do not submit the report until all problems are corrected and successfully re-tested. The report shall include the annotated PVT Plan used during the PVT. Where problems were identified, explain each problem and the corrective action taken. Include a written certification that the installation and testing of the control system is complete and meets all of the contract's requirements.

3.6 TRAINING REQUIREMENTS

Provide a qualified instructor (or instructors) with two years minimum field experience with the installation and programming of similar BACnet DDC systems. Orient training to the specific systems installed. Coordinate training times with the Contracting Officer and BAS Owner after receiving approval of the training course documentation. Training shall

take place at the job site and/or a nearby Government-furnished location. A training day shall occur during normal working hours, last no longer than 8 hours and include a one-hour break for lunch and two additional 15-minute breaks. The project's approved Controls System Operators Manual shall be used as the training text. The Contractor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of training.

3.6.1 Training Documentation

Submit training documentation for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopses of each lesson, and the instructor's background and qualifications. The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

3.6.2 Phase I Training - Fundamentals

The Phase I training session shall last one day and be conducted in a classroom environment with complete audio-visual aids provided by the contractor. Provide each trainee a printed 8.5 by 11 inch hard-copy of all visual aids used. Upon completion of the Phase I Training, each trainee should fully understand the project's DDC system fundamentals. The training session shall include the following:

a. Review of O&M Manual

1. Network Drawing
2. Equipment
3. Flow Diagram
4. Sequence of Operation
5. Wiring
6. Valve Schedule
7. Damper Schedule
8. Bill of Material

b. Network

1. Communication Equipment
2. Configuration Setup of Program
3. Backup Procedures

c. Mechanical Equipment

1. Flow Diagram
2. Wiring & Terminations
3. Hardware Interlocks
4. Sequence of Operation
5. Program Decisions and Illustrations of How Program Meets the Sequence of Operation
6. Global Programming Affecting Each Piece of Equipment

d. Building Data Base

1. Alarm Management
2. Trend Management
3. Building Global Interlocks
4. System Load Shedding & Demand Limiting
5. Utility Data (Water, Steam, Solar)

e. System Tools

1. Network Equipment
2. Supervisory Controllers
3. Equipment Controllers
4. Archives

3.6.3 Phase II Training - Operation

Provide Phase II Training shortly after completing Phase I Training. The Phase II training session shall last one day and be conducted at the DDC system workstation, at a notebook computer connected to the DDC system in the field, and at other site locations as necessary. Upon completion of the Phase II Training, each trainee should fully understand the project's DDC system operation. The training session shall include the following:

a. A walk-through tour of the mechanical system and the installed DDC components (controllers, valves, dampers, surge protection, switches, thermostats, sensors, etc.)

b. Adding and removing network devices

-- End of Section --

SECTION 26 27 14.00 20

ELECTRICITY METERING
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; TIA 2007-1; TIA 2007-2; TIA 2007-3; TIA 2007-4; TIA 2007-5; Errata 2006-1; Errata 2007-2; Errata 2009-3) National Electrical Safety Code
IEEE C37.90.1	(2002; Errata 2003; Errata 2004) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60687	(1992) Alternating Current Static Watt-Hour Meters for Active Energy (Classes 0,2 S and 0,5 S)
IEC 62053-22	(2003) Electricity Metering Equipment (a.c.) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S); Ed 1.0

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering
ANSI C12.18	(2006) Protocol Specification for ANSI Type 2 Optical Port

ANSI C12.20	(2010) Electricity Meters - 0.2 and 0.5 Accuracy Classes
ANSI C12.7	(2005) Requirements for Watthour Meter Sockets
NEMA C12.19	(2008) Utility Industry End Device Data Tables

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011) National Electrical Code

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Stds Dictionary.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]

[Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications shall be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and shall contain no proprietary information and be delivered with unrestricted rights.]

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES[, the CONTRACT CLAUSES and DD Form 1423]:

SD-02 Shop Drawings

Installation Drawings[; G][; G, [_____]]

SD-03 Product Data

Electricity meters[; G][; G, [_____]]

[The most recent meter product data shall be submitted as a Technical Data Package and shall be licensed to the project site. Any software shall be submitted on CD-ROM and [_____] hard copies of the software user manual shall be submitted for each piece of software provided.]

Current transformer[; G][; G, [_____]]

Potential transformer[; G][; G, [_____]]

External communications devices[; G][; G, [_____]]

[Configuration Software[; G][; G, [_____]]

The most recent version of the configuration software for each type (manufacturer and model) shall be submitted as a Technical Data Package and shall be licensed to the project site. Software shall be submitted on CD-ROM and [_____] hard copies of the software user manual shall be submitted for each piece of software provided.

] SD-06 Test Reports

Acceptance checks and tests[; G][; G, [_____]]

System functional verification[; G][; G, [_____]]

Building meter installation sheet, per building[; G][; G, [_____]]

Completed meter installation schedule[; G][; G, [_____]]

Completed meter data schedule[; G][; G, [_____]]

Meter configuration template[; G][; G, [_____]]

Contractor shall fill in the meter configuration template and submit to the Activity for concurrence.

Meter configuration report[; G][; G, [_____]]

The meter configuration report shall be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Electricity Meters and Accessories, Data Package 5[; G][; G, [_____]]

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

System functional verification[; G][; G, [_____]]

1.4 QUALITY ASSURANCE

1.4.1 Installation Drawings

Drawings shall be provided in hard-copy and [_____] electronic format, and

shall include but not be limited to the following:

a. Wiring diagrams with terminals identified of [kilowatt] [advanced] meter, [current transformers,] [potential transformers,][protocol modules,][communications interfaces,][Ethernet connections,][telephone lines]. [For each typical meter installation, provide a diagram.]

b. One-line diagram, including meters, [switch(es),][current transformers,][potential transformers,] [protocol modules,][communications interfaces,][Ethernet connections,][telephone outlets,][and fuses]. [For each typical meter installation, provide a diagram.]

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 1 year prior to bid opening. The 1-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product, or an earlier release of the product, shall have been on sale on the commercial market through advertisements, manufacturers catalogs, or brochures during the prior 1-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3 Material and Equipment Manufacturing Data

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 MAINTENANCE

1.5.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual electricity meters and accessories provided:

a. A condensed description of how the system operates

b. Block diagram indicating major assemblies

c. Troubleshooting information

d. Preventive maintenance

e. Prices for spare parts and supply list

1.6 WARRANTY

The equipment items and software shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment and software on a regular and emergency basis during the warranty period of the contract.

1.7 SYSTEM DESCRIPTION

1.7.1 System Requirements

Electricity metering, consisting of meters and associated equipment, will be used to record the electricity consumption and other values as described in the requirements that follow and as shown on the drawings. Communication system requirements are contained in a separate specification section as identified in paragraph entitled "Communications Interfaces".

1.7.2 Selection Criteria

Metering components and software are part of a system that includes the physical meter, data recorder function and communications method. Every building site identified shall include sufficient metering components to measure the electrical parameters identified and to store and communicate the values as required.

[Contractor shall verify that the electricity meter installed on any building site is compatible with the base-wide metering system with respect to the types of meters selected and the method used to program the meters for initial use. Software and meter programming tools are necessary to set up the meters described by this specification. New software tools different from the meter programming methods currently used by base personnel will require separate approval for use.]

[Contractor shall verify that the metering system installed on any building site is compatible with the facility-wide or base-wide communication and meter reading protocol system.]

PART 2 PRODUCTS

2.1 ELECTRICITY METERS AND ACCESSORIES

[Provide meter(s) and connect the meter(s) to the existing AMI DAS. The contractor shall use the existing government laptop computers to configure the meter using existing software loaded on the computer. The contractor will not be allowed to modify any software or add any additional software to the computer. Alternatively, the government will configure the meter(s), which must be compatible with the existing system, using existing software. Contract shall insure that the meter(s) will transmit the specified data to the DAS. The current meters being used by [_____] are: [ION 8600A meters with X MB of memory] [_____].]

2.1.1 Physical and Common Requirements

a. Provide metering system components in accordance with the Metering System Schedule shown [in this specification][on the drawings]. Provide Meter configuration template.

b. [Replace all existing meter bases. For socket arrangements, use meter and base form of 9S unless installation-specific limitations require the use of a different form type. For panelboards, switchboards, and

switchgear, match the existing installation with the new meter base.] [Existing meter bases can be re-used if they are electrically functional, in physically good condition, and show no signs of corrosion on the electrical contacts. If the existing meter base is usable, the meter base determines meter form factor. If a new meter is being installed, use meter and base form factor of 9S unless installation-specific limitations require the use of a different form type.] [If use of a socket adaptor arrangement has been approved by the activity, contractor shall verify that all clearances are met and doors are able to be properly closed.]—

c. [Meter shall have NEMA [3R] [3R stainless steel] enclosure for surface mounting with bottom or rear penetrations.]

d. Surge withstand capability shall conform to IEEE C37.90.1.

e. Use #12 SIS (XHHW, or equivalent) wiring with ring lugs for all meter connections. Color code and mark the conductors [as follows:

(1) Red - Phase A CT - C1
(2) Orange - Phase B CT - C2
(3) Brown - Phase C CT - C3
(4) Gray with white stripe - neutral current return - C0
(5) Black - Phase A voltage - V1
(6) Yellow - Phase B voltage - V2
(7) Blue - Phase C voltage - V3
(8) White - Neutral voltage]

2.1.2 Potential Transformer Requirements

a. Meter shall be capable of connection to the service voltage phases and magnitude being monitored. If the meter is not rated for the service voltage, provide suitable potential transformers to send an acceptable voltage to the meter.

b. Voltage input shall be optically isolated to 2500 volts DC from signal and communications outputs. Components shall meet or exceed IEEE C37.90.1.

c. Provide [a pull-out type fuse block containing] one fuse per phase, Class RK type, to protect the voltage input to the meter. Size fuses as recommended by the meter manufacturer. Fusing shall either be inside the secondary compartment of the transformer or inside the same enclosure as the CT shorting device.

[d. Potential transformers will be used to convert 480 volt inputs to 120 volts for the locations shown on the metering schedule. Potential transformers shall be rated indoor or outdoor, as required for the specific application. Voltage rating shall provide 120 volts, wye-connected, 3 phase, 4 wire, 60 Hz, insulation class, 600 volts. Potential transformers BIL shall be 10 kV and shall have an accuracy class of 0.3 at burdens w, x, and y. Thermal rating shall be 500 VA.]

[e. The Contractor shall be responsible for determining the actual voltage ratio of each potential transformer for medium voltage applications. Transformer shall conform to IEEE C57.13 and the following requirements.

(1) Type: Dry type, of two-winding construction.

(2) Weather: Outdoor or indoor rated for the application.

(3) Frequency: Nominal 60 Hz.

(4) Accuracy: Plus or minus 0.3 percent at 60 Hz.

f. Potential transformers installed inside switchgear and panels shall be rated for interior use. Voltage rating shall provide 120 volts, wye-connected, 3 phase, 4 wire, 60 Hz, insulation class, 600 volts. Potential transformers BIL shall be a minimum of 10 kV, and have an insulation class and BIL rating that equals or exceeds the ratings of the associated switchgear. Potential transformers shall have an accuracy class of 0.3 at burdens w, x, and y. Thermal rating shall be 500 VA. Potential transformers shall be accessed from the front and mounted in a metering section.]

2.1.3 Current Transformer Requirements

a. Current transformer shall be installed with a rating as shown in the schedule.

b. Current transformers shall have an Accuracy Class of 0.3 (with a maximum error of plus/minus 0.3 percent at 5.0 amperes) when operating within the specified rating factor.

c. Current transformers shall be solid-core, bracket-mounted for new installations using ring-tongue lugs for electrical connections. Current transformers shall be accessible and the associated wiring shall be installed in an organized and neat workmanship arrangement. Current transformers that are retrofitted onto existing switchgear busbar can be a busbar split-core design.

d. Current transformers shall have:

(1) Insulation Class: All 600 volt and below current transformers shall be rated 10 KV BIL. [Current transformers for 2400 and 4160 volt service shall be rated 25 KV BIL.]

(2) Frequency: Nominal 60 Hz.

(3) Burden: Burden class shall be selected for the load.

(4) Phase Angle Range: 0 to 60 degrees.

e. Meter shall accept current input from standard instrument transformers (5A secondary current transformers).

f. Current inputs shall have a continuous rating in accordance with IEEE C57.13.

g. Provide one single-ratio current transformer for each phase per power transformer with characteristics listed in the following table.

Single-Ratio Current Transformer Characteristics

Single-Ratio Current Transformer Characteristics

kVA	Sec. Volt	CT Ratio	RF	Meter Acc. Class
kVA	Sec. Volt	CT Ratio	RF	Meter Acc. Class
[500]	[208Y/120]	[1200/5]	[1.33]	[0.3 thru B0.05]
[750]	[480Y/277]	[800/5]	[1.33]	[0.3 thru B0.05]

2.1.4 Meter Requirements

[Notwithstanding any other provision of this contract, meters shall be [ ] ; no other product will be acceptable.]

[Electricity meters shall include the following features:

a. Meter shall comply with ANSI C12.1, NEMA C12.19, and ANSI C12.20.

b. Meter sockets shall comply with ANSI C12.7.

[c. Meter shall comply with IEC 62053-22, certified by a qualified third party test laboratory.

d. Meter shall comply with IEC 60687 certified by a qualified 3rd party test laboratory.]

e. Provide socket-mounted or panel mounted meters as indicated on the meter schedule.

[(1) Panel- mounted meters shall be semi-flush, back-connected, dustproof, draw-out switchboard type. Cases shall have window removable covers capable of being sealed against tampering. Meters shall be of a type that can be withdrawn through approved sliding contacts from fronts of panels or doors without opening current-transformer secondary circuits, disturbing external circuits, or requiring disconnection of any meter leads. Necessary test devices shall be incorporated within each meter and shall provide means for testing either from an external source of electric power or from associated instrument transformers or bus voltage.]

[(2) For meter replacement projects, meter shall match the existing installation.]

f. Meter shall be a Class 20, transformer rated design.

g. [Use Class 200 meters for direct current reading without current transformers for applications with an expected load less than 200 amperes, where indicated.]

h. Meter shall be rated for use at temperature from minus 40 [ ] degrees Centigrade to plus 70 [ ] degrees Centigrade.

i. The meters shall have an electronic demand recording register and shall be secondary reading as indicated. The register shall be used to

indicate maximum kilowatt demand as well as cumulative or continuously cumulative demand. Demand shall be measured on a block-interval basis and shall be capable of a 5 to 60 minute interval and initially set to a 15-minute interval. It shall have provisions to be programmed to calculate demand on a rolling interval basis. Meter readings shall be true RMS.

j. The meter electronic register shall be of modular design with non-volatile data storage. Downloading meter stored data shall be capable via an optical port. Recording capability of data storage with a minimum capability of 89 days of 15 minute, 2 channel interval data. The meter shall be capable of providing at least 2 KYZ pulse outputs (dry contacts). Default initial configuration (unless identified otherwise by base personnel) shall be:

(1) First channel - kWh
(2) Second channel - kVARh
(3) KYZ output #1 - kWh
(4) KYZ output #2 - kVARh

k. All meters shall have identical features available in accordance with this specification. The meter schedule identifies which features shall be activated at each meter location.

l. Enable switches for Time of Use (TOU), pulse and load profile measurement module at the factory.

m. Meter shall have an optical port on front of meter capable of speeds from 9600 to a minimum of 19.2k baud, and shall be initially set at 9600 baud. Optical device shall be compatible with ANSI C12.18.

n. Meters shall be 120-480 volts auto ranging.

o. Provide blank tag fixed to the meter faceplate for the addition of the meter multiplier, which will be the product of the current transformer [and potential transformer] ratio and will be filled in by base personnel on the job site. The meter's nameplate shall include:

(1) Meter ID number.
(2) Rated voltage.
(3) Current class.
(4) Metering form.
(5) Test amperes.
(6) Frequency.
(7) Catalog number.
(8) Manufacturing date.

p. On switchboard style installations, provide switchboard case with disconnect means for meter removal incorporating short-circuiting of current transformer circuits.

q. Meter covers shall be polycarbonate resins with an optical port and reset. Backup battery shall be easily accessible for change-out after removing the meter cover.—

r. The normal billing data scroll shall be fully programmable. Data scroll display shall include the following.

(1) Number of demand resets.
(2) End-of-interval indication.
(3) Maximum demand.
(4) New maximum demand indication.
(5) Cumulative or continuously cumulative.
(6) Time remaining in interval.
(7) Kilowatt hours.

s. The register shall incorporate a built-in test mode that allows it to be tested without the loss of any data or parameters. The following quantities shall be available for display in the test mode:

(1) Present interval's accumulating demand.
(2) Maximum demand.
(3) Number of impulses being received by the register.

t. Pulse module simple I/O board with programmable ratio selection.

u. Meters shall be programmed after installation via an optical port. Optical display shall show TOU data, peak kWh, semi-peak kWh, off peak kWh, and phase angles.

v. Self-monitoring to provide for:

(1) Unprogrammed register.
(2) RAM checksum error.
(3) ROM checksum error.
(4) Hardware failure.
(5) Memory failure.
(6) EPROM error.
(7) Battery status (fault, condition, or time in service).

w. Liquid crystal alphanumeric displays, 9 digits, blinking squares confirm register operation. 6 Large digits for data and smaller digits for display identifier.

x. Display operations, programmable sequence with display identifiers. Display identifiers shall be selectable for each item. Continually sequence with time selectable for each item.

y. The meters shall support three modes of registers: Normal Mode, Alternate Mode, and Test Mode. The meter also shall support a "Toolbox" or "Service Information" (accessible in the field) through an optocom port to a separate computer using the supplied software to allow access to instantaneous service information such as voltage, current, power factor, load demand, and the phase angle for individual phases.

z. Meter shall have a standard [4] [ ]-year warranty.]

2.1.5 Disconnect Method

a. Provide a 10-pole safety disconnect complete with isolation devices for the voltage and current transformer inputs, including a shorting means for the current transformers.

[b. Disconnecting wiring blocks shall be provided between the current

transformer and the meter. A shorting mechanism shall be built into the wiring block to allow the current transformer wiring to be changed without removing power to the transformer. The wiring blocks shall be located where they are accessible without the necessity of disconnecting power to the transformer.

c. Voltage monitoring circuits shall be equipped with disconnect switches to isolate the meter base or socket from the voltage source. [Provide fuse protection in accordance with paragraph entitled "Voltage Requirements"]]

2.1.6 Installation Methods

a. Transformer Mounted ("XFMR" in Metering Systems Schedule). Meter base shall be located outside on the secondary side of the pad-mounted transformer.

b. Stand Mounted Adjacent to Transformer ("STAND" in Metering Systems Schedule). Meter base shall be mounted on a structural steel pole approximately 1.2 meters 4 feet from the transformer pad. This can be used for multiple meters associated with a single transformers.

c. Building Mounted ("BLDG" in Metering Systems Schedule). Meter base shall be mounted on the side of the existing building near the service entrance.

d. Panel Mounted. ("PNL" in Metering Systems Schedule). Meter shall be mounted where directed.

e. Commercial meter pedestal ("PED" in Metering Systems Schedule).

2.2 COMMUNICATIONS INTERFACES

Meter shall have two-way communication with the existing data acquisition system (DAS). Provide a communications interface utilizing [_____]. [Refer to Section [ ] for the communication interface requirements for these meters.]

Provide interfacing software if a meter is used that is different than the existing meters at the Activity to ensure compatibility within the metering system.

Connect to the AMI network utilizing [_____].

[Provide [_____].]

2.3 SPARE PARTS

[Provide the following spare parts:

a. Power Meter - two for each type used with batteries.

b. Communications interface - one for each type used.]

2.4 METERING SYSTEM SCHEDULE

[ ]

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70 (National Electrical Code), and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.1.1 Existing Condition Survey

The Contractor shall perform a field survey, including inspection of all existing equipment, resulting clearances, and new equipment locations intended to be incorporated into the system and furnish an existing conditions report to the Government. The report shall identify those items that are non-workable as defined in the contract documents. The Contractor shall be held responsible for repairs and modifications necessary to make the system perform as required.

3.1.1.1 Existing Meter Sockets

In some cases, the existing meter sockets will have to be replaced to accommodate the new electrical meters. An existing socket is considered unacceptable for any of the following conditions:

a. It is a non-ANSI form factor meter socket.

b. It is weathered beyond the point of being safe to reuse.

c. It is installed incorrectly, such as a non-weather resistant enclosure installed outdoors.

d. It is not the correct form factor for the existing electrical service.

3.1.1.2 Existing Installations

As part of the existing condition survey, the following applies for installations with existing meters:

a. Replace any meters that do not comply with this section.

b. If CTs are installed, verify that they comply with this section. If they do not comply, replace them with CTs that comply with this section. One CT per phase is required for wye-connected systems.

[c. If potential transformers are installed on low-voltage systems, remove the PTs as part of the installation.]

d. Install disconnect switches as specified in this section.

3.1.2 Scheduling of Work and Outages

The Contract Clauses shall govern regarding permission for power outages, scheduling of work, coordination with Government personnel, and special working conditions.[ ]

3.1.3 Configuration Software

The standard meter shall include the latest available version of firmware and software. Meter shall either be programmed at the factory or shall be programmed in the field. Meters shall have a password that shall be provided to the contracting officer upon project completion. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. When interfacing software is used for a meter that is different than the existing meters in use at the Activity, turn the software over to the Contracting Officer at completion of the project.

3.2 FIELD QUALITY CONTROL

Perform the following acceptance checks and tests on [a random sample of 10 percent of the installed meters as designated by the Contracting Officer] [all installed meters].

3.2.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

a. Meter Assembly

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specifications and approved shop drawings.

(b) Inspect physical and mechanical condition. Confirm the meter is firmly seated in the socket, the socket is not abnormally heated, the display is visible, and the ring and seal on the cover are intact.

(c) Inspect all electrical connections to ensure they are tight. For Class 200 services, verify tightness of the service conductor terminations for high resistance using low-resistance ohmmeter, or by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(d) Record model number, serial number, firmware revision, software revision, and rated control voltage.

(e) Verify operation of display and indicating devices.

(f) Record password and user log-in for each meter.

(g) Verify grounding of metering enclosure.

(h) Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements. Verify that the CT ratio and the PT ratio are properly included in the meter multiplier or the programming of the meter. Confirm that the multiplier is provided on the meter face or on the meter.

(i) Provide building meter installation sheet, per building for each facility. See example Graphic E-S1.

(j) Provide the completed meter installation schedule for the installation. See example Graphic E-S2.

(k) Provide the completed meter data schedule for the installation. See example Graphic E-S3.

(2) Electrical tests.

(a) Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.

(b) Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.

(c) After initial system energization, confirm measurements and indications are consistent with loads present.

(d) Make note of, and report, any "Error-Code" or "Caution-Code" on the meter's display.

(3) Provide meter configuration report.

b. Current Transformers

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specification and approved shop drawings.

(b) Inspect physical and mechanical condition.

(c) Verify correct connection, including polarity.

(d) Inspect all electrical connections to ensure they are tight.

(e) Verify that required grounding and shorting connections provide good contact.

(2) Electrical Tests.

Verify proper operation by reviewing the meter configuration report.

[c. Potential Transformers

(1) Visual and mechanical inspection.

(a) Verify potential transformers are rigidly mounted.

(b) Verify potential transformers are the correct voltage.

(c) Verify that adequate clearances exist between the primary and secondary circuit.

(2) Electrical Tests.

(a) Verify by the meter configuration report that the polarity and phasing are correct.]

3.2.2 System Functional Verification

Verify that the installed meters are working correctly in accordance with the meter configuration report:

a. The correct meter form is installed.

b. All voltage phases are present.

c. Phase rotation is correct.

d. Phase angles are correct.

e. The new meter accurately measures power magnitude and direction, and can communicate as required by paragraph entitled "Communications Interfaces".

-- End of Section --

Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Design Strategies for Energy Use Reduction to Consider During DD Form 1391 And Development of Construction Solicitation Documents

Criteria:

1. ASHRAE/IESNA Standard 90.1-2007 "Energy Standard for Buildings Except Low-Rise Residential Buildings"
2. UFC 3-400-01 dated 5 July 2002 Including Change 4, August 2008 "ENERGY CONSERVATION".
3. COMNAVREGMIDLANTINST 4100.1, REGIONAL ENERGY MANAGEMENT PROGRAM, Dated 28 Sept 2009
4. ECB 2008-03, Acceptance Testing of Critical Systems
5. NAVFAC Engineering and Construction Bulletin (ECB) 2008-01, Energy Policy Act of 2005 Implementation and USGBC LEED® Certification

NAVFAC tools:

Utilize the NAVFAC tools from the NAVFAC web site: See NAVFAC Sustainable Development Program - Tools at: http://www.wbdg.org/references/pa_dod_sust_tools.php

This site covers 6 tools: Here are the two most important tools:

Navy 1391 Sustainable Design Cost Tool: http://www.wbdg.org/docs/navy_1391_leed.xls

The primary use of this tool is to identify sustainable features and their costs to achieve the requirements of the Energy Policy Act 2005, Executive Order 13423 (implements Federal Leadership in High Performance and Sustainable Buildings MOU), Energy Independence and Security Act 2007 (EISA) and a minimum LEED® Silver-level rating certified by USGBC, to include in the Budget Estimate Summary Sheet of the DD Form 1391. The total cost of these items will be carried over to the EPAct2005/LEED® Silver line item in Block 9 of DD Form 1391.

Energy Conservation tool: http://www.wbdg.org/docs/energy_conserve_measure_toolkit.xls

This tool is intended to be a companion tool to the Navy 1391 Sustainable Design Cost Tool and has been expanded to include worksheets for seven facility types common to the Department of Defense. Each facility worksheet recommends Energy Conservation Measures (ECMs) for building components and systems which are identified for specific climate zones.

1. Commissioning:

Provide Enhanced Commissioning.

The change to Enhanced Commissioning is located at LEED-NC (latest version) EA Credit 3. Enhanced commissioning requires the involvement of the Commissioning Agent (CA) to review the building operation for 10 months and resolve the issues. NAVFAC MIDLANT's policy is for the Contractor and the CA to optimize all of the electrical and mechanical systems to the system peak operating efficiencies as an Energy feature, however, *change the time from 10 months to 12 months*. Enhanced commissioning resolves by keeping the project on design target and goals, keeps construction from deviating from design, fine tunes systems, ensures that operators are trained, ensures that systems are maintained, and improves energy efficiency.

2. ECB 2008-03 Acceptance Testing of Critical Systems, dated 25 Sept 08:

Incorporate the requirements of the engineering Construction Bulletin ECB 2008-03 in the acceptance testing of critical systems. Why?

The ECB requires focus towards NAVFAC's technical oversight of acceptance testing during construction of five critical areas (electrical, fire and life safety, mechanical, roofing, and underwater structures) to ensure the constructed facility performs as intended and meets the needs of the supported commands; to define the use of Post Construction Award Services (PCAS) funding as it applies to the Capital Improvements Business Line (CIBL) in-house acceptance testing and technical support efforts. This supplements the Enhanced Commissioning. Here is the link for the ECB: https://portal.navfac.navy.mil/portal/page/portal/docs/doc_store_pub/ecb2008-03.pdf

3. ENERGY STAR ® Labeled facility:

Provide ENERGY STAR® Label facility. Why?

This is a major energy feature. This feature registers the project as an ENERGY STAR® Label facility. It offers national recognition and a posting on the Department of Energy (DOE) web site. NAVFAC MIDLANT proposes that the Contractor and A/E provide facilities that meet or are better than the Department of Energy' s requirements for ENERGY STAR® Label for Commercial Buildings. Provide for a minimum target overall rating of 90. After one year of operation the Contractor, CA and the A/E shall accumulate the required energy usage data and submit applications to obtain the Energy Star® label for each facility. The Contractor shall apply the label to each facility and register the facility as an ENERGY STAR® Label facility. A copy of 2009 Professional Engineer's Guide to the ENERGY STAR® Label for Commercial Buildings is available on the DOE web site. All equipment provided shall have the ENERGY STAR® Label. The A/E shall obtain an Energy Star® labeled design for each facility.

What it means:

a. A 90 rating means this in the top 10% of all similar facilities having energy saving features
b. National Recognition with a DOE posting
c. A building with an Energy Star® Label
d. Requires all equipment and systems to have the Energy Star® Label
e. Design shall be an Energy Start® Label design
f. Requires 12 months of energy monitoring.
g. Using Enhanced LEED® Commissioning for 12 months, the contractor, CA, and A/E shall monitor the building to make sure it keeps on the Energy Target. If the building is off-Target, the Contractor, A/E, and the CA shall resolve issues to bring the facility back on Target.

4. ASHRAE 90.1-2007:

Incorporate the latest ASHRAE 90.1 standard. Why? The project scope may have been previously defined to meet ASHRAE 90.1-2004.

The new standard raises the energy savings requirement. Design the facility to have energy usage of 40% less than ASHRAE 90.1-2007. This is the current requirement that NAVFAC MIDLANT is incorporating on current design projects. The 30% standard was changed to 40%.

Provide facility envelope improvements, interior and exterior lighting improvements, HVAC system and equipment efficiency improvements, building control system improvements, and other energy saving improvements to reduce annual energy consumption to 40% minimum below ASHRAE 90.1-2007 The 40% shall be calculated using the methodology outlined in the UFC 3-400-01.

5. Optimize the Building Envelope:

Optimize the exterior building envelope to reduce energy. This goes hand in hand with ASHRAE 90.1. Increase the wall insulation and roof insulation. Exceed the latest ASHRAE 90.1 requirements. NAVFAC MIDLANT is incorporating this on current design projects.

6. Optimize the Window Requirements:

Optimize the window strategy to reduce energy even further. Utilize latest version of ASHRAE 90.1 requirements and exceed them. Consider additional thermal insulation capabilities, insulated frames, shading effects, and consider shading devices such as overhangs to reduce the solar load on the windows.

NAVFAC MIDLANT is incorporating this on current design projects. Consider reducing window size *unless* it impacts LEED® factors for daylighting.

7. Radiant Barriers in the Walls:

Incorporate radiant barriers in the wall systems to reduce the radiant heat transfer, and reduce the energy transfer through the walls. NAVFAC MIDLANT is incorporating this on current design projects.

8. Radiant Barriers in the Roof

Incorporate radiant barriers in the roof system to reduce the radiant heat transfer, and reduce the energy transfer through the roof. This will require a major attention to the attic and roof design. The roof materials must be considered because the radiant barrier will increase the roof temperature.

9. Increase Building Envelope Tightness

Incorporate building envelope-tightness building design to reduce air infiltration by providing sealing throughout the envelope. This requires specific details on the drawings as well as specifications for the sealing and testing techniques. Provide building air tightness by reducing the air infiltration through the envelope to 0.25 CFM per envelope area (square feet) at 0.3 inches water gauge pressure. This reduces the effect of energy from reducing infiltration. See the attached Building envelope air tightness requirement.

10. Water Heater Efficiencies:

Consider 80% to 90% or greater. Current design is based on 80% combustion efficiency, which is standard. Changing the water heater design to a condensing type will increase the efficiency to 90% or greater.

11. Supplement Hot Water with Energy Recovery

Provide energy recovery with hot water – utilize the hot water storage tank. Recover energy from the Chiller condenser to supplement the hot water storage heating source.

12. Hot Water Distribution System:

Provide Variable Speed pumping for hot water pumps

Provide high efficiency pumps and motors.

13. Chiller:

Optimize the chiller plant, including the chilled water pump.

a. Look at increasing the chiller efficiency. Increase the Chilled Water temperature difference from 10 degree rise to 11 or 12 degrees. For Constant speed chillers, for every 1 degree increase in chilled water temperature can increase the chiller energy efficiency by 1 to 2%.
b. Increase the pump efficiency and motor efficiency.
c. Consider variable speed primary pumps for chilled water.
d. Optimize the chilled water plant operation via DDC.
e. If the Public Works Department agrees, use water cooled chiller instead of an air cooled chiller.

14. Interior Room Design Condition:

Change the design from 75^{o} F dry bulb as shown on Drawing M1-001 to 76^{o} F dry bulb as required by UFC 3-400-10N, Paragraph 3-2.1.3, Cooling Indoor Design Conditions.

15. Apply the requirements of 2007 Energy Independence and Security Act.

Optimize the lighting efficiencies as well as meet new ASHRAE 90.1-2007

Optimize equipment efficiencies to improve to beat the EISA 2007act.

Solar Hot Water – EISA 2007: requires 30% minimum of the hot water demand to be provided by solar water heating system, if life cycle cost effective. Payback period is considered to be *40* years. (Note: some clients may require this feature even if the payback is greater than 40 years.) Consider 100% of the hot water demand as well.

Provide solar water heating – Develop the hot water system design in conjunction with the HVAC systems, in meeting EPACT 2005. Evaluate the domestic hot water system types or combination of types, in view of meeting the EPACT 2005, EISA 2007 and the LEED® requirements for this project. Perform a life cycle cost analysis on these systems and include with the EPACT 2005 calculations. Submit

calculations at the 35% design submittal. Select a hot water service system based on fully meeting the EPACT 2005 and EISA 2007 goals. Provide analysis for using energy reclamation from chillers and/or geothermal heating, natural gas storage type heaters, natural gas storage heaters supplemented by solar water heating system, and supplemented by solar-assisted water source heat pumps in view of achieving LEED® credits under EA Credit 1 (Optimize Energy Performance). EISA 2007 requires that 30% of the hot water demand shall be provided by solar water heating system if life cycle cost effective. Provide energy calculations, system design and life cycle cost calculations.

16. Optimize the HVAC Systems:

Evaluate three general HVAC system types in view of meeting EPACT 2005, UFC 3-400-01 and the LEED® requirements for this project. The following four HVAC systems are those that have been found to be used the most. Prepare a life-cycle cost analysis for these three HVAC systems and the two heat distribution systems. Select an HVAC system based upon fully-meeting EPACT 2005, UFC 3-400-01 requirements and the LEED® requirements. UFC 3-400-01 dated 5 July 2002, including Change 4 dated August 2008, "ENERGY CONSERVATION" – use latest versions. Base the life cycle cost on first cost, yearly maintenance cost, energy costs, operating costs, and system/equipment replacement costs. The Designer of Record shall select an HVAC system type based upon fully meeting the energy conservation requirements and the overarching LEED® Silver requirement, and favoring the most life-cycle cost effective system. The systems shall be evaluated on the basis of life cycle cost on the following factors over a time period of *40* years:

1. First cost or cost of installation and materials
2. Cost of maintenance and repair
3. Cost of operation
4. Energy usage and cost
5. Energy Savings and Cost in savings
6. Cost of replacement

The four systems to be evaluated vary in first cost, operation cost, maintenance cost, replacement cost, life cycle cost, and energy costs, and offer corresponding increases in energy efficiency, and the systems are as follows:

The four HVAC systems vary in first cost and offer corresponding increases in energy efficiency, and they are as follows:

a. VAV Systems: High efficiency air-cooled chiller(s) and natural gas. Consider using Chilled water with variable primary pumping and hot water loops with variable flow. System shall consist of VAV air handling units serving VAV fan powered terminal units throughout the facility and a dedicated outdoor air system with 100% exhaust air energy recovery using total enthalpy heat wheel(s). Perform life cycle cost calculations.

b. Variable refrigerant flow (VRF) cooling and heating systems using multiple packaged outdoor heat recovery units with digital variable speed scroll compressors, and multiple split indoor evaporators with simultaneous heating and cooling capability using heat recovery and supplemental hot water coil. Include primary/secondary pumping for hot water loops. Provide a separate and dedicated 100% outdoor air conditioning system feeding neutral air to each individual zone/space using direct expansion (DX) cooling, hot water heating, pre-heat and reheat using hot water, and energy recovery from exhaust air using total enthalpy heat wheel. Hot water heating will be from the hot water supply via natural gas. VRF systems shall meet ASHRAE 15 and 34 standards. Refrigerant systems shall meet ASHRAE 15 and 34 standards, International Mechanical Code, and Local and/or State Mechanical Codes, as required. System design shall ensure the refrigerant volume of a system does not exceed the refrigerant concentration limit per unit volume as defined in ASHRAE 34 and the local and State Mechanical Codes for the smallest occupied space. In addition, and if used, VRF systems shall be designed and installed in accordance with the detailed requirements as attached.

c. Ground Source Heat Pumps (GSHPs): Geothermal well field with condenser water loop serving ground-source heat pumps (GSHP) located throughout the facility. Consider supplemental energy such as steam heated hot water or hot water from other energy sources such as gas,

electric, etc as required to support condenser water temperatures during the heating season, if required and backed up by analyses. Analyze best heat source if required using life cycle cost analysis. Consider utilizing a closed circuit cooling tower to supplement the ground source condenser water during the cooling season if required. Provide a separate and dedicated 100% outdoor air conditioning system feeding neutral air to each individual zone/space using GSHP, hot water heating, pre-heat and reheat using hot water, and energy recovery from exhaust air using total enthalpy heat wheel.

d. Water Source Heat Pumps (WSHPs): Closed-circuit cooling tower(s) with condenser water loop serving water-source heat pumps (WSHP) located throughout the facility. Supplemental heating to condenser loop will be from the available energy supply using hot water. Dedicated 100% outdoor air conditioning system feeding neutral air to the individual WSHP units using direct expansion (DX) cooling, hot water heating, and energy recovery from exhaust air using total enthalpy heat wheel. Hot water heating will be from the available energy supply.

Ground source heat pumps and associated systems shall meet Unified Facilities Guide Specifications (UFGS) Section 23 81 47 "WATER-LOOP AND GROUND-LOOP HEAT PUMP SYSTEMS." The geothermal well field and GSHP systems is suggested to be designed 15% oversized using software specifically designed to simulate this system type. The contractor shall follow the requirements of UFGC specification UFGS 23 81 47 Water-Loop and Ground-Loop Heat Pump Systems for geothermal well field and the ground source heat pump system. The contractor shall perform tests at the site to evaluate the conductivity and performance of the soil for geothermal heat exchange. The contractor shall determine the general geothermal well field size and location that best meet the site requirements and shall come up with their own estimates of well field size for the purpose of bidding. The well field shall fit within the site and not impede on adjacent sites or future development planned for those sites. As a minimum, the ground source heat pump well shall meet the local and state well requirements and shall be fully permitted. Each well shall have its own Local and/or State well permit, as required. Each well shall be full grout from top to bottom in accordance with local and or State requirements and the well depth shall be of a depth that is no deeper than allowed by State regulation (for example 150 feet or less in North Carolina), depending on the local and State well requirements – Verify depth with the local and State requirements. Each well shall have a minimum thermal diameter influence of 20 feet, meaning the well spacing between wells shall be a minimum of 20 feet Each well shall not exceed one ton of cooling. Contractor shall provide in-Situ testing to determine heat transfer characteristics of the soil and potential well output. Provide a minimum of 4 in-situ test locations per building. Suggest to provide a separate and dedicated outdoor air system to each space and room.

17. Provide heat recovery from shower drains. Provide this strategy where there are a large number of showers.

18. Lighting Power densities:

Optimize the lighting power densities. Must exceed ASHRAE 90.1-2007 requirements.

Provide daylighting strategy.

19. Demand Control Ventilation:

Provide Demand Control Ventilation utilizing either CO2 or infrared room sensors. If room infrared sensors are used, they can reduce the outside air demand to rooms, when rooms are unoccupied. With demand control ventilation utilize variable speed controls on outside air fan, exhaust air fan, and heat wheel to vary outside air in accordance to demand and still meet ASHRAE 62 requirements.

20. Ventilation: Provide ventilation that meets ASHRAE 62. Calculate the ventilation effectiveness. Strive for 100% effectiveness by requiring ducted exhaust from each room

20. Room Sensor: Along with demand control ventilation, consider utilizing a room sensor that will engage the room lights, room power, exhaust, increase the room supply from minimum, HVAC, etc. The room sensor can be infrared.

21. Room Card Reader System: In lieu of a room sensor, consider a room card or CAC card for use rooms such as quarters. As in a BEQ or BOQ: when the occupant is in the room, the room energy

systems would be engage by the card reader system. When the occupant leaves the quarters the room energy would be reduced to a minimum value when the card is removed.

22. UFC 3-400-01, Energy Conservation

Use the latest edition. Except utilize 40% less than ASHRAE 90.1-2007.

23. Duct Seal Class:

Increase the duct seal to reduce the duct losses – Use max seal class, A.

24. Mechanical System Insulation:

Increase thermal insulation on mechanical systems and utilize radiant barriers to reduce thermal losses.

25. DX Systems

Minimize the use of DX systems. Consider using Variable refrigerant flow (VRF) cooling and heating systems. See Item 16 above

For split DX systems: Use where they are required. Specify high efficiency split system units. Use at least 13 SEER.

Prefer high efficient heat pump systems.

When required using Centralized Direct Expansion (DX): Consider packaged cooling with VAV and heating from the available energy supply. Primary/secondary pumping for hot water loops. VAV air handling units serving VAV terminals throughout the facility. Dedicated 100% outdoor air conditioning system feeding neutral air to the VAV air handlers using direct expansion (DX) cooling, hot water heating, and energy recovery from exhaust air using total enthalpy heat wheel. Hot water heating will be from the available energy supply. This approach has to beat the other four systems above in item 16.

26. Optimize the Boiler sizing.

Use 85% combustion efficiency or higher, may have to change boiler type. In optimizing the boiler efficiency include some form of burner control which allows for fully modulating burners with variable frequency drives and fans. Provide for low NOx emissions. Consider multiple packaged boilers for higher operation efficiency. Multiple boilers are better able to match the current load with boiler capacity and cycle on and off less frequently. Utilize controls to stage the boilers on as required to match the load. Utilize boilers with powered or forced draft burners, instead of atmospheric burners. Consider re-circulating flue gases for optimal combustion with minimal excess air. Utilize electronic control systems that monitor flue-gas components and adjust fuel and air as needed. Provide greatly improved turndown ratios to improve efficiency at less than peak load. Review flue gas temperatures – may require stainless steel flues.

27. Provide Renewable sources

Provide Photovoltaic power See CNRMA Energy Instruction for minimum requirements.

Provide Solar Hot Water Heating (See item 15 on EISA 2007 above)

Get half the power at Navy shore installations from alternative energy sources - including wind or solar - by 2020, and where possible, supply energy back to the grid.

28. Provide high efficiency motors.

29. Consider ultra high efficiency motors

These motors have very high efficiency with power unloading very close to the centrifugal blower's power and speed cubic relationship, lowering operating costs significantly at reduced speeds. These motors are called Electronically Commutated Motors (ECM) and are DC motors, with a permanent magnet rotor and ball bearings and an internal microcontroller.

30. Provide digital ballast for light fixtures

31. Ensure the project includes Rainwater harvesting. Goal to save the use of domestic water – Provide water usage reduction: 2% per year with a total reduction of 16% by 2015. This is also covered in CNRMA Energy Instruction.

32. Meet the requirements of the MOU – Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU), dated 24 January 2006

33. Metering: All incoming utilities shall be metered and monitored via the DDC. All utilities shall be metered is required by EISA 2007 and EPACT 2005. Metering shall be used for the purposes of efficient energy use and reduction in the cost of the utility. Provide utility grade meters that data at least daily and measure the consumption of electricity at least hourly. Utilize advanced metering, which consists of sub-metering. The metering will be part of the EMCS/DDC controls. Consider meter data transfer to GIS via EMCS/DDC.

34. Minimize Energy usage, maximize efficiency, consider life-cycle costs and utilize the referenced criteria requirements when acquiring new equipment or systems, as well as vendors' efficiency or energy policies.

35. EMCS/DDC: Consider utilizing Energy Monitoring Control System (EMCS) and Direct Digital Control (DDC). EMCS and DDC can provide energy savings by monitoring and control of utilities, advanced metering such as sub-metering, HVAC, etc. See attached Energy Monitoring Control System/Direct Digital Control Systems (EMCS/DDC) Strategy (First Draft)

DEPARTMENT OF THE NAVY
NAVY CRANE CENTER
NAVAL FACILITIES ENGINEERING COMMAND
NORFOLK NAVAL SHIPYARD, BUILDING 491
PORTSMOUTH, VIRGINIA 23709-5000.

IN REPLY REFER TO

NAVCRANECENINST 11450.1A
31 Mar 11

NAVCRANECEN INSTRUCTION 11450.1A

From: Director, Navy Crane Center

Subj: ACQUISITION OF NAVY SHORE BASED WEIGHT HANDLING EQUIPMENT

Ref: (a) SECNAVINST 11260.2A Navy Weight Handling Program for Shore Activities
(b) NAVFAC P-307 Management of Weight Handling Equipment

1. Purpose: To establish acquisition policy for Navy shore based weight handling equipment (WHE) as authorized by reference (a).

2. Cancellation: NAVCRANECEN Instruction 11450.1

3. Applicability: This instruction applies to WHE purchased for and assigned to the Navy shore establishment, excluding:

a. Civil Engineering Support Equipment (CESE) mobile cranes procured through Naval Facilities Expeditionary Logistics Center (NFELC).
b. Mobile cargo cranes under the cognizance of NAVSUP 538 and procured through NAVSUPSYSCOM.
c. Aviation support cranes procured by NAVAIRSYSCOM.
d. Equipment addressed in paragraph 14.1.1 of reference (b), except as noted in paragraph 5.

Note:
Contracts for mobile cargo cranes and CESE mobile cranes shall require the contractor, at the receiving activity's option, to either:
i. Perform a complete condition inspection and load test in accordance with reference (b) at the contractor's facility prior to shipment, or
ii. Be on site (or on call at the activity's option) to witness the activity's condition inspection and load test in accordance with reference (b).
In either case, the contractor shall provide a representative to perform a receipt inspection and initial setup of the crane after delivery to the activity. Navy Crane Center (NAVCRANECEN) assistance is available for this inspection and testing.

4. Background: Reference (a) assigns to the Commander, Naval Facilities Engineering Command (NAVFAC) responsibility for all matters pertaining to the Navy's weight handling program at Navy shore activities. Reference (a) further states that these

responsibilities shall be accomplished through NAVCRANECEN directly reporting to the Commander, NAVFAC. In accordance with reference (a), NAVCRANECEN is responsible for:

a. Establishing acquisition policy,
b. Acquiring WHE in accordance with NAVCRANECEN Navy Shore Based WHE Acquisition Policy, and
c. Assisting Navy shore activities and NAVFAC FECs in programming WHE projects.

NAVCRANECEN is available to assist Navy shore activities and NAVFAC FECs in self-procurement of WHE where such self-procurement is authorized in accordance with this instruction.

In accordance with reference (a), Navy Crane Center acquisition services are funded on a cost reimbursable basis.

5. Navy Shore Based WHE Acquisition Policy:

a. Except for exclusions noted in paragraph 3, NAVCRANECEN is the required Procuring Contract Office for new procurement, replacement, or overhaul* of the following WHE:

(1) Any capacity portal crane, hammerhead crane, derrick, floating crane, tower crane, mobile boat hoist or rubber tired gantry crane.
(2) Overhead traveling cranes, gantry cranes, wall cranes, jib cranes, davits, pillar cranes, pillar jib cranes, monorails, and hoists with rated capacities of 20,000 pounds or greater.
(3) Any capacity WHE, including portable powered hoists, used in the following applications:
    (a) Ordnance handling.
    (b) Molten metals.
    (c) Special Purpose Service (SPS) as defined in NAVSEA Publication 0989-030-7000.
    (d) "Hazardous Area Applications" as defined in the National Electrical Code.
    (e) Precision handling operations requiring complex or synchronized lifting capacity.
(4) Any capacity WHE requested by foreign countries under the Military Assistance Program when specifically authorized by the cognizant DoD Agency.

* Overhaul for purpose of determining the required Procuring Contract Office is defined as renovation or modernization of cranes that directly affect multiple major components or systems and involve more than one engineering discipline.

b. NAVCRANECEN performs the following services on a NAVCRANECEN WHE procurement:

(1) Confirm WHE scope of work, budget, and schedule. An initial site visit is usually required. For WHE being installed in new facilities, NAVCRANECEN will provide crane wheel loads, electrical power requirements, and clearances for crane installation. NAVCRANECEN will participate in the facility design process by reviewing facility submittals relating to the WHE, and attending coordination meetings as required.
(2) Prepare an Acquisition Agreement for supported command and NAVCRANECEN signatures.
(3) Prepare the design-build contract documents for the WHE.
(4) Issue the Request for proposal.
(5) Award the WHE contract.
(6) Review the WHE submittals for compliance with the contract requirements.
(7) Witness the contractor performed WHE shop tests.
(8) Provide on-site quality assurance during the removal, installation, and acceptance testing of the WHE.
(9) Accept the WHE – NAVCRANECEN coordinates with the local certifying official so the certifying official can use the NAVCRANECEN acceptance test to certify the WHE.
(10) Provide warranty support for one year following crane acceptance.

c. To initiate a NAVCRANECEN procurement, contact NAVCRANECEN Project Manager & Business Director at 757-967-3810. Crane information forms for bridge cranes are available on the NAVCRANECEN website https://portal.navfac.navy.mil/ncc to facilitate communication of required characteristics. These same forms may be used to identify the salient characteristics of other types of WHE (e.g., mobile boat hoists, rubber tired gantry cranes, etc.) to assist in the technical specification development process.

d. NAVCRANECEN waiver process: With the exception of SPS WHE, Navy shore activities may request one-time authority from NAVCRANECEN to procure WHE. The following actions are required in order to obtain a waiver for self-procurement of WHE:

(1) Submit a letter signed by the Commanding Officer, Public Works Officer, or equivalent of the activity responsible for procuring the WHE requesting authority to procure the WHE. The letter shall include: a description of the WHE, including where it will be located; the reason for requesting a waiver; the method of procurement; the process for having the WHE certified; and a point of contact (POC) concerning operational/technical issues.
(2) NAVCRANECEN will call the POC to discuss NAVCRANECEN's role in the procurement (reviewing or preparing the specification, reviewing the submittals, and/or being on-site for the acceptance test).
(3) NAVCRANECEN will issue a letter either approving the waiver noting the conditions for approval or denying the waiver.

e. Navy shore activity self-procurement of WHE: With the exception of applications listed in paragraph 5.a, Navy shore activities may procure new or replacement WHE with capacities of less than 20,000 pounds. If Navy shore activities elect to procure WHE, NAVCRANECEN technical and/or quality assurance assistance is available, upon request. Contact the NAVCRANECEN Director of Project Management and Business at telephone 757-967-3810 or Director of Crane Design at telephone 757-967-3822. The following stipulations apply:

(1) NAVCRANECEN shall be consulted on allowable configuration for overhead electric traveling (bridge) cranes with spans exceeding 40 feet.
(2) Navy shore activities shall use the applicable Unified Facilities Guide Specifications (UFGS) to prepare WHE solicitation. UFG specifications are located at http://www.wbdg.org. NAVCRANECEN is available to review a specification upon request. If a UFGS is not available for the type of WHE proposed, the activity shall coordinate with NAVCRANECEN to determine if the WHE can be locally procured or should be a NAVCRANECEN procurement.
(3) Ensure WHE is certified by the local certifying official in accordance with reference (b) before being placed in operation.
(4) Navy shore activities without crane engineering expertise shall contact NAVCRANECEN to discuss procurement of the WHE.

S. E. BEVINS

Distribution:
NAVCRANECEN Internet https://portal.navfac.navy.mil/ncc
NAVFAC Internet https://portal.navfac.navy.mil

Rev 1.25.10
Minor rev 5.12.10
Previous 7.2.09

MCB CAMP LEJEUNE, N.C. MECHANICAL POLICIES

HVAC

1. Use the latest revision of ASHRAE 62 for guidance on indoor air quality. For the purposes of outside air ventilation only, typical occupancy is considered that which happens at least once a week for buildings that follow a regular schedule or at least 15 times a year for non-schedule type buildings.

2. Chilled water VAV with zone reheat is the preferred HVAC system **for offices** and should be considered wherever appropriate. VAV zone boxes with out fans are preferable to units with fans. **In non-fan powered zone boxes, when specifying minimum air flow the designer shall consider diffuser dumping. If a zone has a large variance of load profile from neighboring zones a fan powered box should be considered to avoid dumping of diffusers. Chilled water VAV with fan powered terminal units is the preferred HVAC system for BEQ/BOQ's. Zone reheat shall be as specified in the scope (10.14.08). VAV Fan powered terminal units shall have a fan volume of 50 cfm to 50% greater than the maximum primary air flow. (1.8.10) Minimum primary air flow should match the ventilation rate required. (5.12.10).**

3. Particular attention should be given to humidity control by air conditioning equipment. Cooling units 7.5 tons and smaller shall not have modulating water controls unless based on a constant 55 F supply temperature. Larger units may have split face coils to give capacity step control (progressive modulating chilled water valves may be used). Modulating face and bypass dampers are okay on any size equipment

4. Rooftop HVAC equipment should be used with discretion. Maintenance access is more difficult, controls and water piping are exposed to more extreme conditions and roof is exposed to more abuse and wear. Ladders permanent or temporary inhibit personnel, material and equipment access, and therefore stairways shall be provided to roof top equipment**.**

5. Avoid HVAC systems that modulate cooling supply air temperatures unless outside air is separately conditioned.

6. Avoid use of chilled water fan coil (FCU) systems due the high maintenance associated with them. Coil condensate drain pans are especially problematic. If FCU's are used, ensure adequacy of the drain system.

7. Provide aluminum fins on copper tubes with coating that passes the ASTM B117-90 3000 hour salt spray resistance test for all outdoor coils larger than 10 tons. The heat transfer rating of phenolic-coated coils should be as installed (ie after coating).

8. Air cooled chillers are preferred to water cooled equipment for individual equipment smaller than 150 tons. Camp Lejeune weather is mild and humid which only gives slight efficiency advantage to water cooled equipment. Larger plants such as multiple 400 ton chillers should be water cooled. The efficiency advantage overcomes the additional maintenance of cooling towers.

9. Do not use steam absorption chillers. Helical screw compressors are desirable. Reciprocating and scroll compressors are acceptable. Where applicable on large installations centrifugal equipment is acceptable, (greater than 150 tons). **Oiless centrifugal is acceptable for water cooled applications (1.25.10)**

10. Provide adequate thermal mass in chilled water systems to ensure proper control and longevity of chillers. Chiller manufacturers recommend 2 to 7 minute water loop return times; use a minimum of 5 minutes to size inertia tanks and/or increase pipe sizing/length.

11. Provide primary/secondary pumping systems on multiple building chiller systems and on systems larger 150 tons. **Keep flow thru the chiller constant. Do not use variable primary flow (2.22.10).** Ensure primary loop has sufficient thermal inertia. Be aware that the secondary loop has little influence on staging cycling during low load conditions. (6.20.8)

12. HVAC equipment should not be installed in attics or above suspended ceilings, unless absolutely necessary. When placement in an attic is dictated by necessity, provide stairs to access the attic, and maintenance access to and space around equipment; ships ladders are undesirable. **Provide drain pan float switch to shut down condensing unit or close chilled water valve to the coil. (6.26.9)**

13. Air handling unit filter access doors should be specified as hinged with non-tool captive latching devices, ie captive thumb screws, quarter turn latches etc**.** Do not specify or approve access panels that are unhinged and/or retained by sheet metal screws.

14. Require contractors to provide a listing of the HVAC filters for each piece of equipment along with their dimensions (width, height and thickness) and types (permanent/washable, throwaway, etc)

15. Do not use plastic preinsulated pipe for buried dual temperature water distribution; use preinsulated copper pipe. **HDPE is acceptable for chilled water applications. (6.13.8)**

16. Do not specify mineral fiber or flexible unicellular insulation on chilled water pipes. Use rigid insulation on all pipes subject to being stepped on or damaged. Cellular glass, or polyisocyanurate up to 1-½ inches (40 mm) thick is preferred on chilled water pipes and other pipes below ambient temperature **including domestic cold water. (1.25.10)**

17. Use solids from water separators on all hydronic systems regardless of pipe material (steel or copper).

18. **Automatic flow control balancing valves should only be used in conjunction with piping systems employing solids from water separators, regardless of piping material. (6.26.09)**

19. Isolate "steam" mechanical rooms from building. All steam equipment is more prone to leaking, thus making the room humidity saturated. Provide the steam room with an exterior door; do not provide a door(s) to adjacent spaces. Keep electrical equipment out of this room. If possible separate steam rooms from cold equipment rooms. Minimize controls in steam mechanical rooms. Only controls necessary for equipment in the room shall be allowed. If it is convenient put controls in adjacent room. It is preferable to keep air handlers out of this room also. Do not run high pressure steam outside the steam room(ie steam entrance should be directly into steam mechanical room). Separate building for steam equipment and pumps is good. Provide exhaust fan ventilation with 20ac/hr on cooling thermostat.

20. Ventilate "hot" rooms and electrical rooms sufficient to mitigate heat gain

21. Do not ventilate cold equipment rooms. Cold equipment rooms are those rooms with chilled water pumping, cooling air handlers chillers, etc. These rooms should be unvented and with small dehumidifier. Drain condensate to floor drain or other disposal location. Summer dew point ranges from low to high 70's at Camp Lejeune causing condensation on equipment and piping.

22. Do not permit 400 series refrigerants except 407C and 410A. 400 series refrigerants are zeotropes and cause maintenance problems. **Use of 407C is discouraged, as it is a short term stop gap measure that the manufacturers can drop into basically a R22 machine. Designer shall research the availability of 410A and/or 134A equipment. If sufficient competition is available with 410A and/or 134A, prohibit the use of 407C and R22. 5.22.09**

23. Do not permit/specify engine driven refrigeration equipment.

24. Outside air intakes should be in compliance with force protection criteria, ie; minimum of 10' above finished grade.

25. A/C terminal units with compressors shall be easily removed. On water source equipment that means unions on the equipment side of the service valves.

26. Design and specify bladder type expansion tanks with automatic air relief valve on air separator.

27. Paint all dual temp and chilled water steel pipe and equipment before insulation is installed. **This in addition to shop primer and or mill coating. (1.28.10)**

28. Keep in mind fall hazards when locating equipment. Provide necessary fall protection.

29. In refrigerated rooms/boxes: specify all evaporators on a condensing unit to defrost together, separate evaporator/condensing unit pairs should defrost non-concurrently.

30. Provide phase monitors on all 3 phase equipment. For chillers the following shall be included:
    a) phase unbalance protection
    b) over/under voltage protection
    c) phase loss protection
    d) Delay of break timer to delay automatic restarts
    e) non critical fault delay
    f) programmable auto/manual restart
    g) load and line side monitoring

    For all other equipment only phase loss, phase reversal, and phase unbalance need to be monitored. Reset shall be automatic upon correction of the fault.

31. On chillers and large condensing units; provide core filter dryer on suction line as available as standard option

32. On chillers and large condensing units; provide liquid and suction line service valves as available as standard option.

33. Do not permit welding on chillers. Water connections shall be by grooved coupling or flanges. Provide 16-20 mesh strainer on water inlet**.**

34. Do not permit grooved couplings in piping system other than the chiller connection. (6.13.8)

35. Extruded Tee's in copper piping are acceptable for mains 2" and larger with the branch ½ or less than the main. Joint must be brazed. (6.13.8**)**

36. Do not permit press type fittings in copper. (6.13.8)

37. Require 5 year warranty on compressor parts. Require 5 year warranty on labor if available.

38. DUCT WORK: specify and draw 45 degree expanded throat take offs with balance damper for all supply run outs to diffusers and grills. Do not permit flexible duct runs exceeding 8' long. Specify that all 90 degree turns be accomplished with hard metal elbows, such as on top of diffusers, and if top take off of trunk duct.

39. Pump Packages: In general do not specify pump/heat exchanger packages. Most of our mechanical rooms are on the smallish side. Pump packages require maintenance space on all sides. If specifying a pump package, designer must work out general lay out of package and mechanical room to ensure maintenance access.

40. Circulating pumps for hot water, chilled water, or dual temperature shall be inline pumps when pumps are installed in noise sensitive areas, or when redundant pumps are used. Other wise base mounted pumps shall be used. For inline pumps 5 hp and larger include rigging points for maintenance.

41. **When a partial renovation of a building HVAC system re-uses existing piping, specify the contractor to clean and flush the existing piping. (1.8.10)**

42. In buildings where cooling is not available 12 months/year, consider the use of ductless split systems for conference rooms. Consider the use of Package Terminal Heat Pumps for high internal heat spaces such as server rooms.

43. **The use of ceiling return air plenums is discouraged and shall not be used in new construction. (2.10.10**)

GAS PIPING

44. When installing LP or natural gas fired equipment, if the total load is less 1.2 million btu input, specify multiple boilers/water heaters that each have an input of less than 400,000 btu/hr. At 400,000 btu/hr input the boiler or water heater becomes a utility boiler that entails increased surveillance, inspection and maintenance. Under 400,000 btu/hr input the equipment is simply a heating appliance with no maintenance requirements

45. The design for LP gas tanks shall be as follows:
    a) construction contractor to provide:
    i. 6" thick concrete slab, 6'x8' for 500 gallon tank, 6'x16' for 1000 gallon tank (6.10.9)
    ii. Underground gas line to stub up through oversized sleeve in slab, 3"from edge
    iii. 1st stage regulator
    iv. Protective bollards, 7'long, 4" schedule 40 galvanized steel, concrete filled, 3' bury with concrete encased, paint bright yellow/black with 4" stripes.
    v. Make tank hook up
    vi. Purchase at construction contractor's expense LP gas for start up, and construction period.
    b) Camp Lejeune will arrange rental, including placement, but not hook up, of the tank. Camp Lejeune will contract for tank fill up after BOD of project.
    c) Designer shall specify size of the tank (typical sizes are 123, 500, & 1000 gallon), size and location of the concrete pad, and placement/number of protective bollards. Bollards shall be place to protect from the grass cutters (each open corner), and nearby traffic (may require intermediate bollard spacing). Design shall comply with all applicable codes. As a reminder, 500 gallon tank shall be minimum of 10' from the building, 1000 gallon tank shall be minimum of 25' from the building. The long axis of the tank shall be parallel with the building.
    d) AROICC will notify Camp Lejeune metering & LP tank inspector (currently Brian Soo @ 545-9222) of the need/timing of tank placement, and tank fill after BOD.

46. **On LP systems, first stage regulator is located at the LP tank and should be set for 10 psig. The second stage regulator should be located on the exterior of the building wall in a protected location. Provide a building shut off valve on all systems. (1.19.2010).**
47. **Size interior gas piping with a 15% safety buffer. I.E. Size the piping for 15% more demand than anticipated. (1.28.10)**
48. **Common interior gas pressures are 7", 2 psi, and 5 psi. Use 7" if 2" or smaller piping can serve the load, otherwise use 2psi with regulators at each appliance. (1.28.10)**

CONTROLS

49. Avoid use of economizers (dry bulb or enthalpy). High humidity and poor control reliability prohibit success with economizers except in extremely high internal load buildings.
50. Direct Digital Control (DDC) systems are the preferred HVAC control systems for new and replacement control systems. ~~Pneumatics should only be used for applications such as for pilot operators on large control valves~~. (**5.19.8)**

51. Where DDC is not practical, such as with small unitary equipment, use Smart Thermostats

52. CO2 sensors and outside air modulation should be considered in facilities with highly varying occupancies.

53. Specify that pneumatic control devices be able to withstand 30 psi without damage.

54. Control valve actuators shall be spring return normally open on preheat coils and other coils subject to freezing, spring return closed on hot water converters, and spring return closed on outside air dampers**.** (10.22.08)

55. Specify individual scheduling for air handlers. Specify a gradual (progressive) startup and a gradual (progressive) shut down of air handlers. A sudden startup or shut down of the entire building is too fast for chiller controls to react and sometimes causes safety trips.

PLUMBING

56. Lubrication oil lines should not be installed below building floor slabs. **It is preferred that lubrication oil lines be installed overhead. If this is not possible or desirable by the customer, lines** within service bays should be installed in trenches with removable tops. **(6.26.9)**

57. Install shop air compressors in accessible locations with appropriate space for periodic service. Shop air compressors **are serviced by the building occupants and** (6.26.09) should not be installed within mechanical rooms since occupant access is prohibited by base maintenance. Shop air compressors should be provided with sufficient cooling ventilation. Install air compressors associated with building HVAC controls within mechanical rooms.

58. Air compressor receivers over 5 cubic feet (37.4 gal) are unfired pressure vessels that must under go hydrostatic and operational tests witnessed by the base boiler inspector. (5.19.8)

59. Air Compressors should be mounted on vibration pads/mounts. Specify/show flexible connectors on the piping. (10.22.08**)**

60. Where practical provide hose bibs near all HVAC coils for wash down/cleaning purposes.

61. Provide floor drains in all mechanical rooms.

62. Provide trap primers on all floor drains except locations that are expected to get regular use thru out the year. **Trap primer shall be pressure type installed on a cold water line, and shall not be installed on a flush valve.(2.27.9)**

63. Provide sectional shut off valves for domestic hot & cold water for each bathroom (group).

64. Do not permit lever type control handles on pressure balance shower valves in BEQ's. This type of handle invites the user to pull for volume control, thereby breaking the handle.

65. Avoid frost proof hose bibs.

66. Provide strainers on RPZ back flow preventers**.**

67. Double Check and RPZ type back flow preventers (BFP) shall be tested/certified by the installing contractor prior to BOD. Add the following paragraph to any specification section that includes a BFP(10.22.08).

3.X Back Flow Preventer Certification: After installation all double check and reduce pressure zone type back flow preventers shall be inspected, tested and certified by a certified tester. Submit tester certification and Test Data Certification Sheet**.**

68. Extruded Tee's in copper piping are acceptable for mains 2" and larger with the branch ½ or less than the main. Joint must be brazed. (6.13.8)

69. Do not permit rolled grooved connections in domestic water copper piping.

70. Combination waste & vent is discouraged. Make use of circuit venting where appropriate.

71. Drain lines serving commercial dishwashers should be high silicone cast iron. Drains serving low temperature mild acid such as carbonated beverage machine drains should be PVC. Indicate on the drawings drain line material.

72. Domestic water piping shall be type L copper for above ground and type K copper for below grade. Do not permit press fittings. For O&M projects cross linked Polyethylene (PEX) is permitted when largest pipe can be served by 1" PEX. (5.19.8)

STEAM

73. Meters are required for steam, water and electrical service to MWR facilities and all other reimbursable customers.

74. **Avoid (5.19.8)** steam pits within mechanical rooms. Steam lines should be counter flowed from an exterior manhole.

75. Steam condensate receiver pumps should be steam pressure powered. Do not use electric duplex condensate pumps. ~~Servicing electric duplex condensate pumps cause an overlap of responsibility between the electrical and mechanical trades.~~(1.25.10)

76. Minimize use of steampits. Those required must be raised 18 inches (450 mm) above finish grade and equipped with a full grated top. Steampits are required for the connection and valving of building service lines. Drip legs can be direct buried with steam trap above ground in a "doghouse" if the steam pit is not required for other reasons. Steampits are required at low points and end of mains in order to gravity drain condensate for cold start up of distribution system. ~~**Install two traps in these locations. The first trap is the normal high pressure drip returning to the condensate system. The second trap dumps to drain and locks closed when steam pressure exceeds 15 psig.**~~ **(1.25.10).**

77. Do not use FRP pipe for buried steam condensate lines. Use schedule 80 black steel pipe in condensate systems.

78. Steam tunnels and trenches are preferred by base utilities over direct buried preinsulated steam and condensate systems. Trench tops may double as a sidewalk where appropriate.

79. **Direct buried steam and condensate piping shall be drainable, dryable, testable. Do not include thermal performance testing or sensors (ie. Delete from guide specification). Edit the testing specification as follows: Socket welded pipe does not need to be tested. As an alternative to radiographic testing, the butt welds may be ultrasonically tested. The report shall be similar to that of the radiographic exam, i.e., examiner shall sign and date report, defects and location shall be noted, weld shall be graded acceptable or unacceptable, etc. Welded connections shall not be covered until the government selects 10% of the connections to be tested. (5.26.09)**

80. Use externally pressurized bellows expansion joints when inline expansion in steam lines is required and where loops cannot be utilized. Slip tube expansion joints are acceptable but not preferred over externally pressurized bellows joints.

81. Provide check valves and test valves at all steam condensate drip stations.

82. Base operating steam pressures are as follows:

Steam Plant	Steam Pressure
Plant 1700	150 psi (1034 kPa)
Plant AS4151	150 psi (1034 kPa)
Plant G650	100 psi (690 kPa)
Plant M625	100 psi (690 kPa)
Plant RR15	50 psi (345 kPa)
Plant PP2615	50 psi (345 kPa)
~~Plant M230~~	~~50 psi (345 kPa)~~(decommissioned)
Plant BB9	100 psi (690 kPa)
Plant NH100	100 psi (690 kPa)

83. Specify steam control valve actuators that can withstand heat conducted from steam lines and equipment. Do not specify, or approve, hydraulic powered actuators in steam applications.

84. Install blow down valves on all strainers.

85. It is preferred to distribute hot water thru out building or building complex for heating in lieu of direct steam heat.

86. Insulate pipes with rigid insulation where pipes are subjected to being stepped on or damaged, such as low above ground lines and steam pits; cellular glass insulation is preferred.

87. Specify flange gaskets to be metal spiral wound ASME B16.20.

88. Pump Packages: In general do not specify pump/heat exchanger packages. Most of our mechanical rooms are on the smallish side. Pump packages require maintenance space on all sides. If specifying a pump package, designer must work out general lay out of package and mechanical room to ensure maintenance access. (12.31.07)

89. All steam pressure powered pumps (PPP) shall have a direct acting pressure regulator on the motive steam. Provide pressure gages on the motive steam line and the condensate collection system. Regulator to be set for 20 psi higher than the condensate back pressure. Regulator shall be 20' from PPP, or the line between the regulator and the pump shall be oversized. (12.31.07)

90. Ensure that all steam heated equipment with modulating steam control valves have vacuum breakers, air vents, and gravity drain to a condensate receiver. Show sufficient details to ensure contractor pipes accordingly. The mechanical room plan shall also allow for this. If a pumping trap is required, show it on the drawing. (12.31.07**)**

91. **Valves for 100psi and greater steam shall be steel bodied valves. (1.28.10)**

92. **Camp Lejeune has introduced flooded vertical heat exchangers that use line pressure steam and a control valve on the condensate discharge in lieu of a steam control valve thereby omitting the need for a steam pressure regulator, steam pressure safety valve, steam control valve and a condensate pump. Coordinate with the Public Works project manager to coordinate the use of the traditional steam system or the flooded vertical heat exchanger on each project. Contact the mechanical branch manager to get the standard detail and about application. (1.28.10)**

FIRE PROTECTION

93. Require as built shop drawings of sprinkler systems both as a printed copy on mylar and as an electronic file on CD in Autocad.dwg (12.31.07)
94. **Interim policy for fire protection systems in Hadnot Point, industrial, and French Creek Areas (does not include Wallace Creek): Camp Lejeune has planned projects to increase system pressures from 50-60 psi to 70-80 psi. All fire protection systems that require fire pumps shall be designed to operate without the fire pumps with a 70 psi system pressure. The exception to this is if UFC requirements can not be met even with the higher pressure. (1.19.2010)**
95. **When installing more than one riser, require a check valve (alarm check) on each riser to reduce the chance of all risers alarming when ever one riser flows. Show the backflow preventer test header on the riser diagram. (1.28.10)**
96. **Require the use of two piece ceiling cup/plate for sprinklers installed in lay in ceilings. This permits future replacement of ceiling tiles without disturbing the sprinklers. Do not permit hinged escutcheons. (1.28.10)**

SWIMMING POOLS (5.10.09)

97. Swimming pool chemistry and filters are monitored by PW Utilities and pools shall be equipped as followings.

98. Pool shall have pool controller that automatically monitors and feeds sodium hypochlorite and sulfuric acid, and backwashes the filter.

    a) Controller shall read ORP or free chlorine, and PH.
    b) Controller shall transmit free chlorine, and PH values to the corresponding water plant via radio.
    c) Pool water temperature shall also be sensed and transmitted on indoor pools.
    d) Controller shall transmit a master alarm to the corresponding water plant via radio in the event of high or low ORP or PH levels, no sensor water flow, and elapsed chemical feed alarm.
    e) Chemical feed system shall be interlocked to shut off in the event of no pool circulation water flow.
    f) The preferred pool controller is Bec System 7.
    g) Electronics shall have a 60 minute battery backup.

99. Filter backwash shall have manual over-ride such that the filters can be backwashed in the event of controller failure.

100. Normal pool water waste shall be to the sanitary sewer, with a bypass to the storm sewer. This can be used to empty pool after dechlorination. **A dechlorinator shall be installed. (7.2.09)**

101. A normally energized duplex receptacle needs to be installed near the chemical feed pumps to manually feed chemicals in the event of pool controller failure. **If chemical feed is controlled by energizing/de-energizing the receptacle supplying the feed pumps, each pump shall have a separate, independent, and labeled receptacle. (7.2.09)**

102. Minimum chemical storage for an indoor Olympic size pool shall be 300 gallons of sodium hypochlorite, and 150 gallons of sulfuric acid. **Chemical storage shall be proportional to pool size. Outdoor pools require increased storage capacity. All chemical storage tanks shall have secondary containment. Chemical rooms shall be mechanically vented, dedicated to chemical storage and large enough to increase the storage by 50%. Chemical rooms shall be located with easy access by delivery tanker truck. Entrances to chemical room shall be labeled with Hazmat Placard. (7.2.09)**

103. Do not use brass saddles at chemical injection points. Use PVC.

104. Do not locate normally serviced equipment such as pumps, backflow preventers, lint traps, etc in pits. **Equipment that requires regular operation, service, or maintenance shall not be located in confined spaces. (7.2.09)**

105. The contractor shall modify the front end software at the water plant to receive and display the new pool.
   a) Wallace creek recreation center shall transmit to the building 20 water plant.
   b) The wounded warrior pool shall transmit to the building 670 water plant.

106. Swimming pools shall comply with 15A NCAC 18.A2500, (North Carolina Rules for Public Swimming Pools), with the following exception: Do not provide an integral vacuum system as called for in 15A NCAC 18A.2518(g). The pool chemistry is maintained by the PW Utilities. The cleaning is done by the pool operators. We do not want pool operators to have access to the pump room, which would be necessary if an integral vacuum system were installed.

107. **Filter rooms should have a pedestrian door and an 8'x8' roll up door for forklift and pallet access. Provide differential pressure gage across each filter to be easily read while standing in front of filter. (7.2.09)**

ENERGY

108. **Building thermal envelope assemblies shall at a minimum meet the prescriptive requirements of ASHRAE 90.1 with the following exceptions. (2.10.10)**

109. **Metal and wood studs walls shall be 6" with R19 insulation. (2.10.10)**

110. **Mass walls shall have a minimum of R10 rigid insulation between wythes of masonry or on the exterior of the massive layer. Insulation in the cells of CMU does not fill this requirement. (2.10.10)**
111. **Roof insulation shall be R30, except for metal panel construction where blanket insulation is placed between purlins and metal panels the insulation may be R19. (2.10.10)**
112. **Windows shall meet ATFP requirements, laminated, meet ASHRAE 90.1 prescriptive requirements. No tilting sashes are permitted. (2.10.10)**

SECTION 26 56 00.00 22

EXTERIOR LIGHTING
06/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS ANSI O5.1	(2008) Wood Poles -- Specifications & Dimensions

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS-5	(2009; Errata 2009; Amendment 2010) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C136.20	(2008) American National Standard for Roadway and Area Lighting Equipment - Fiber Reinforced Composite (FRC) Lighting Poles

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C4	(2003) Poles - Preservative Treatment by Pressure Processes
AWPA M6	(2007) Brands Used on Forest Products

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 108/B 108M	(2008) Standard Specification for Aluminum-Alloy Permanent Mold Castings

ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM C 1089	(2006) Standard Specification for Spun Cast Prestressed Concrete Poles
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM G 154	(2006) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)

EN 60529	(1991; A1 2000) Degrees of Protection Provided By Enclosures (IP Code)

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9	(2000; Errata 2004; Errata 2005; Errata 2006) IES Lighting Handbook
IESNA LM-79	(2008) Electrical and Photometric Measurements of Solid-State Lighting Products
IESNA LM-80	(2008) Measuring Lumen Maintenance of LED Light Sources
IESNA TM-15	(2007; Addendum 2009) Luminaire Classification System for Outdoor Luminaires
IESNA RP-8	(2000; Errata 2004; R 2005; Errata 2007) Roadway Lighting

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2007; Errata 06-1; TIA 07-1; TIA 07-2; TIA 07-3; Errata 07-2; TIA 08-4; TIA 08-5; TIA 08-6; TIA 08-7; TIA 08-8; TIA 08-9; TIA 08-10; TIA 08-11; TIA 09-12; TIA 09-13; TIA 09-14; Errata 09-3; TIA 09-15; TIA 09-16; TIA 10-17) National Electrical Safety Code
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60068-2-14	(2009) Environmental testing - Part 2-14: Tests - Test N: Change of temperature - Edition 6.0
IEC 60068-2-30	(2005) Environmental Testing - Part 2-30: Tests - Test Db: Damp Heat, Cyclic (12 H + 12 H Cycle); Ed 3.0

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.41	(2006) For Electric Lamps--Guidelines for Low-Pressure Sodium Lamps
ANSI ANSLG C78.42	(2009) For Electric Lamps: High-Pressure Sodium Lamps
ANSI C136.10	(2006) American National Standard for Roadway and Area Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles--Physical and Electrical Interchangeability and Testing
ANSI C136.13	(2004; R 2009) American National Standard for Roadway Lighting Equipment, Metal Brackets for Wood Poles
ANSI C136.21	(2004; R 2009) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
ANSI C136.3	(2005; R 2009) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments
NEMA C136.31	(2010) For Roadway and Area Lighting Equipment— Luminaire Vibration
ANSI C78.1381	(1998) American National Standard for Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
ANSI/ANSLG C78.43	(2007) American National Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
NEMA ANSLG C78.377	(2008) American National Standard for electric lamps— Specifications for the Chromaticity of Solid State Lighting Products

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2006) Enclosures
NEMA WD 7	(2000; R 2005) Occupancy Motion Sensors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011) National Electrical Code

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1728F-700	(1993) REA Specification for Wood Poles, Stubs and Anchor Logs

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint Jun 2010) High-Intensity-Discharge Lamp Ballasts
UL 1310	(2005) Standard for Safety Class 2 Power Units - Fifth Edition; Reprint with revisions through and including September 30, 2010
UL 1598	(2008; Reprint Jan 2010) Luminaires
UL 773	(1995; Reprint Mar 2002) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2006; Reprint Mar 2011) Standard for Nonindustrial Photoelectric Switches for Lighting Control
UL 8750	(2009) Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products - First Edition

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as

defined in IEEE 100.

b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

c. Groundline section is that portion between 305 mm one foot above and 610 mm 2 feet below the groundline.

d. Useful Life is the operating hours before reaching 70% of the initial rated lumen output point with no catastrophic failures under normal conditions.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are[for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Photometric Plan; G

Submit computer generated photometric analysis of the "designed to" values for the "end of useful life" of the lighting installation, using an LLD value of 0.7. Submittal shall include the following:

Horizontal illuminance measurements at finished grade. Spacing between computer calculation points must be 10' maximum.

Vertical illuminance measurements at 5 foot above finished grade

Minimum footcandle level

Maximum footcandle level

Average maintained footcandle level

Maximum and minimum ratio (Horizontal)

Warranty; G

LED Luminaire Warranty; G

SD-02 Shop Drawings

Luminaire drawings; G, [_____]

Poles; G, [_____]

SD-03 Product Data

[Local/Regional Materials

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

[Environmental Data]

Energy Efficiency

Luminaires; G, [_____]

LED Luminaires; G, [_____]

LED Luminaire Daylighting Controls; G

LED Luminaire Photocell Switch; G

LED Luminaire Time Switch; G

LED Luminaire Curfew Control; G

LED Luminaire Occupancy Sensor Controls; G

Lamps; G, [_____]

Ballasts; G, [_____]

Lighting contactor; G, [_____]

Time switch; G, [_____]

Photocell switch; G, [_____]

Concrete poles; G, [_____]

Aluminum poles; G, [_____]

Steel poles; G, [_____]

Fiberglass poles; G, [_____]

Brackets

[Auxiliary instant-on quartz system; G, [_____]]

[SD-04 Samples

Luminaires; G, [_____]

LED Luminaires; G, [_____]

Submit one sample of each luminaire type[, complete with lamp and ballast].[Submit one sample for each item other than luminaires.] Sample will be returned to the Contractor for installation in the project work.

] SD-05 Design Data

Design Data for luminaires; G, [_____]

Wind Loading Calculations, G

SD-06 Test Reports

LED Luminaire IESNA LM-79 Report; G

Submit report on manufacturer's standard production model luminaire. Submittal shall include:

Testing agency, report number, date, manufacturer's name, catalog number, LED driver, drive current, ambient temperature

Luminaire Efficacy (Lumens/watt)

Color Qualities (CCT and CRI)

Electrical Measurements (input voltage, input current, input power (watts))

Spectral Distribution over visible wavelengths (mW/nm)

Absolute Intensity Candlepower (cd) Summary table

Isocandela Plot

Luminance Summary table

Illuminance - Point to Point

Illuminance - Isofootcandle Plot

Picture of sample

Absolute Intensity Candlepower (cd) Summary table

Photometric File including B.U.G. rating in IES Format

LED Luminaire IESNA LM-80 Report; G

Submit report on manufacturer's standard production LED package, array, or module. Submittal shall include:

Testing agency, report number, date, type of equipment, and LED light source being tested.

All data required by IESNA LM-80.

Test laboratories for the IESNA LM-79 and IESNA LM-80 reports shall be one of the following:

National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the

Energy-Efficient Lighting Products laboratory accreditation program.

One of the qualified labs listed on the DOE SSL web site (http://www1.eere.energy.gov/buildings/ssl/test_labs.html).

A manufacturer's in-house lab that meets the following criteria:

a. Manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires and the manufacturer's lab has been successfully certifying these fixtures for a minimum of 15 years,

b. Annual equipment calibration including photometer calibration in accordance with National Institute of Standards and Technology.

[Pressure treated wood pole quality]

[Tests for fiberglass poles; G, [_____]]

Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

SD-07 Certificates

Fixture Useful Life Certificate; G

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life shall be directly correlated to the IESNA LM-80 test data, adjusted for the thermal properties of manufacturer's luminaire, and adjusted for local average ambient operating conditions.

SD-08 Manufacturer's Instructions

Concrete poles

Submit instructions prior to installation.

Fiberglass poles

Submit instructions prior to installation.

SD-10 Operation and Maintenance Data

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.4 QUALITY ASSURANCE

1.4.1 Drawing Requirements

1.4.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and[computerized] candlepower distribution data shall accompany shop drawings.

1.4.1.2 Poles

Include dimensions, wind load determined in accordance with AASHTO LTS-5, pole deflection, pole class, and other applicable information.[For concrete poles, include: section and details to indicate quantities and position of prestressing steel, spiral steel, inserts, and through holes; initial prestressing steel tension; and concrete strengths at release and at 28 days.]

[1.4.2 Pressure Treated Wood Pole Quality

Ensure the quality of pressure treated wood poles. Furnish an inspection report (for wood poles) of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with AWPA M6 and RUS Bull 1728F-700 standards. The RUS approved Quality Mark "WQC" on each pole will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.4.3 Design Data for Luminaires

a. Distribution data according to IESNA classification type as defined in IESNA HB-9.

b. Computerized horizontal illumination levels in lux footcandles at ground level, taken every [3050][6100][_____] mm [10][20][_____] feet. Include average maintained lux footcandle level and maximum and minimum ratio. Provide Photometric Plan for project.

c. Shielding as defined by IESNA RP-8 or B.U.G. rating for the installed position as defined by IESNA TM-15.

d. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification per NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

[1.4.4 Tests for Fiberglass Poles

a. Ultraviolet resistance tests: Perform according to ASTM G 154 using a UV-B lamp having a 313 nanometer wavelength, operated at 54 degrees C 130 degrees F, cycling the lamp on for 4 hours and off for 4 hours for a total test period of 1500 hours minimum with the following results:

Fiber exposure:	None
Crazing:	None
Checking:	None
Chalking:	None
Color:	May dull slightly

b. Flexural strength and deflection test: Test loading shall be as a cantilever beam with pole butt as fixed end and a force simulating wind load at the free end.

1.4.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer. Component parts of the item shall be the products of the same manufacturer, unless stated otherwise in this section.

1.4.6.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if the manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires for a minimum of 15 years. Products shall have been in satisfactory commercial or industrial use for 15 years prior to bid opening. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 15-year period.

1.4.6.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 DELIVERY, STORAGE, AND HANDLING

[1.5.1 Wood Poles

Stack poles stored for more than 2 weeks on decay-resisting skids arranged to support the poles without producing noticeable distortion. Store poles to permit free circulation of air; the bottom poles in the stack shall be at least 305 mm one foot above ground level and growing vegetation. Do not permit decayed or decaying wood to remain underneath stored poles. Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentation more than 25 mm one inch in depth in handling the poles. Do not apply tools to the groundline section of any pole.

[1.5.2 Concrete Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation.

[1.5.3 Fiberglass Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

[1.5.4 [Aluminum][Steel]Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [800][_____] kilometer [500][_____] mile radius from the project site, if available from a minimum of three sources.

1.6.2 Environmental Data

[Submit Table 1 of ASTM E 2129 for the following products: [_____].]

1.6.3 Energy Efficiency

Comply with National Energy Policy Act. [Comply with Energy Star requirements for the following lighting products: [___]].

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7.1 LED Luminaire Warranty

Life of exterior LED lighting (primarily the luminaire) is not yet well understood given the relative newness of the technology for this application. Projected life of LED luminaires is a key component to payback scenarios in project evaluations, therefore it is very important that products perform as anticipated. Since life claims provided by suppliers is typically 50,000 hours or greater and the first cost of exterior LED luminaires may be significant, site Warranty shall assure that the product will perform as claimed in terms of useful life. Provide Fixture Useful Life Certificate.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

2. Material warranty shall include:

(a) All power supply units (PSUs), including drivers.

(b) Replacement when more than 10% of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the Contracting Officer signed warranty certificates prior to final payment.

1.8 POWER SOURCE

[Use a photovoltaic power source.]

1.9 OPERATIONAL SERVICE

Coordinate with manufacturer for [maintenance agreement] [take-back program]. Collect information from the manufacturer about [maintenance agreement] [green lease] options, and submit to Contracting Officer. Services shall reclaim materials for recycling and/or reuse. Services shall not landfill or burn reclaimed materials. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in[Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION,] Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,[Section 33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND,][and] Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.]

2.2 LUMINAIRES

UL 1598 and UL 8750. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

2.2.1 Lamps

2.2.1.1 High-Pressure Sodium (HPS) Lamps

ANSI ANSLG C78.42. Wattage as indicated. HPS lamps shall have average rated life of 16,000 hours (minimum) for 35 watt lamps and 24,000 hours (minimum) for all higher wattage lamps. 150 watt lamps, if required, shall be 55 volt lamps. Lamps shall have Luminaire Efficiency Ratings (LER) as follows:

a. Upward efficiency of 0 percent

1. 150-399 watts: minimum 58 LER for closed fixture; minimum 68 for open fixture

2. 400-999 watts: minimum 63 LER for closed fixture; minimum 84 for open fixture

b. Upward efficiency of 1 percent - 10 percent

1. 150-399 watts: minimum 64 LER for closed fixture; minimum 63 for open fixture

2. 400-999 watts: minimum 82 LER for closed fixture; minimum 89 for open fixture

3. 1000 plus watts: minimum 109 LER for open fixture

c. Upward efficiency of 11 percent to 20 percent

1. 150-399 watts: minimum 78 LER for open fixture

2. 400-999 watts: minimum 94 for open fixture

d. Upward efficiency greater than 20 percent

1. 150-399 watts: minimum 75 LER for closed fixture; minimum 77 for open fixture

[2.2.1.2 Standby HPS Lamps

ANSI ANSLG C78.42. Wattage as indicated. Standby HPS lamps shall have two arc tubes and an average rated life of 40,000 hours (minimum). Hot restart instant lumen output shall be 8 percent, minimum, of total light output. 150 watt lamps, if required, shall be 55 volt type.

[2.2.1.3 Low-Pressure Sodium (LPS) Lamps

ANSI ANSLG C78.41.

[2.2.1.4 Metal-Halide Lamps

Provide luminaires with tempered glass lens.

[a. Double-ended, 70 watt, conforming to ANSI C78.1381]

[b. Single-ended, wattage as indicated, conforming to ANSI/ANSLG C78.43]

Lamps shall have Luminaire Efficiency Ratings (LER) as follows:

a. Upward efficiency of 0 percent

1. 150-399 watts: minimum 41 LER for closed fixture

2. 400-999 watts: minimum 53 LER for closed fixture; minimum 59 for open fixture

3. 1000 plus watts: minimum 77 LER for closed fixture

b. Upward efficiency of 1 percent - 10 percent

1. 150-399 watts: minimum 56 LER for closed fixture

2. 400-999 watts: minimum 62 LER for closed fixture; minimum 64 for open fixture

3. 1000 plus watts: minimum 88 LER for open fixture

c. Upward efficiency greater than 20 percent

1. 150-399 watts: minimum 62 LER for closed fixture; minimum 77 for open fixture

2. 400-999 watts: minimum 65 LER for closed fixture

2.2.2 Ballasts for High-Intensity-Discharge (HID) Luminaires

UL 1029 and ANSI C82.4, and shall be constant wattage autotransformer (CWA) or regulator, high power-factor type (minimum 90 percent). Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30 degrees C. Ballasts shall be:

a. Designed to operate on voltage system to which they are connected.

b. Constructed so that open circuit operation will not reduce the average life.

HID ballasts shall have a solid-state igniter/starter with an average life in the pulsing mode of 10,000 hours at the intended ambient temperature. Igniter case temperature shall not exceed 90 degrees C.

2.3 LED LUMINAIRES

UL 1598 and UL 8750. Provide luminaires as indicated. Provide luminaires complete with LED light source and power supply unit. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

2.3.1 General Requirements

a. Luminaire shall be UL-listed for wet locations and wiring cavity must be field accessible for service or repair needs.

b. Luminaire shall be full cutoff or fully shielded as defined by IESNA RP-8. Alternatively, the full cutoff can be validated by meeting the following IESNA TM-15 B.U.G. Ratings (backlight, uplight, and glare):

1. Maximum uplight (U) rating of U0 for residential areas and U1 for all other areas.

2. Maximum glare (G) rating equal to G0 for residential areas and G2 for all other areas.

c. Optical system for roadway and area luminaires shall be sealed and rated for IP 66 as defined in EN 60529.

d. Luminaire shall be fully assembled and electrically tested prior to shipment from factory.

e. For all mast arm mounted luminaires, a wildlife shield shall be included in the fixture to prevent wildlife access to the fixture.

f. Color of the luminaire shall be bronze unless specified otherwise.

g. The coating must be capable of surviving ASTM B 117 Salt Fog environment for 1000 hrs minimum without blistering or peeling.

h. The coating shall demonstrate gloss retention of greater than or equal to 90% for 1000 hrs exposure QUV test per ASTM G 154 UVB-313 Lamps, 4 hr Condensation 50 °C.

i. Luminaire shall be tested according to IEC 60068-2-14 for thermal shock. Luminaire shall be fully functional after completion of testing.

j. Luminaire shall be tested according to IEC 60068-2-30, damp heat, steady state, for high humidity and high temperatures. Luminaire shall be fully functional after testing.

k. Luminaire arm bolts shall be 304 stainless steel or zinc plated steel.

l. If a lens not integral to the LED is used, construct the luminaire optical enclosure (lens/window) of clear and UV-resistant acrylic or tempered glass.

m. 80% of the luminaire material by weight should be recyclable at end of life.

n. Produce a minimum efficacy of 60 lumens per Watt driven at 350mA or a minimum of 50 lumens per Watt driven at 525mA tested per IESNA LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

o. Incorporate modular electrical connections and construct luminaire to allow replacement of all or any part of the optics, heat sinks, power supply units, and electrical components using only a simple tool, such as a screwdriver.

p. Luminaire shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely

affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

q. Fixture weight and effective projected area (EPA) shall not exceed the pole requirements for wind loading. Provide wind loading calculations.

r. Roadway and area luminaires shall have an integral tilt adjustment of +/- 5° to allow the unit to be leveled, in accordance with ANSI C136.3.

s. Luminaire must pass 3G vibration testing in accordance with NEMA C136.31.

t. Provide LED Luminaire IESNA LM-79 Report and LED Luminaire IESNA LM-80 Report.

2.3.2 Wiring

All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist style wire nuts are not acceptable.

2.3.3 Power Supply Units

UL 1310. Power Supply Unit (PSU) including drivers shall meet the following requirements:

a. Minimum efficiency of 85%.

b. Drive current per LED shall not exceed 525mA ±10%.

c. Rated to operate between ambient temperatures of -30°C and [+40°C] [+50°C].

d. Designed to operate on voltage system to which they are connected ranging from 120 V to 277 V nominal.

e. Operating frequency: 50/60 Hz.

f. Power Factor (PF): Greater than or equal to 0.90.

g. Total Harmonic Distortion (THD) current: Less than or equal to 20%.

h. FCC Part 15 Class B.

i. Reduction of Hazardous Substances (RoHS) compliant.

j. Luminaires under a covered structure such as canopies shall be UL listed with a sound rating of "A."

[k. Driver shall be dimmable and compatible with a standard Dimming Control circuit of 0 - 10V.]

2.3.4 LED Light Source

a. Luminaires must be rated for operation in ambient temperatures of -30°C to [+40°C] [+50°C].

b. Correlated Color Temperature (CCT) shall be in accordance with

NEMA ANSLG C78.377.

[Nominal CCT: 3000 K: 3045 ± 175 K or Nominal CCT 3500 K: 3465 ± 245 K]

[Nominal CCT: 4000 K: 3985 ± 275 K or Nominal CCT 4500 K: 4503 ± 243 K]

[Nominal CCT 5000 K: 5028 ± 283 K or Nominal CCT 5700 K: 5665 ± 355]

[Nominal CCT: 6500 K: 6530 ± 510 K]

c. Color Rendering Index (CRI) shall be:

[Greater than or equal to 80 for 3000 K - 3500 K]

[Greater than or equal to 70 for 4000 K - 6500 K]

2.3.5 Surge Protection

Provide surge protection integral to luminaire to meet "C Low" waveforms as defined in IEEE C62.41.2, Scenario 1 Location Category C.

2.3.6 LED Luminaire Daylighting Controls

All exterior parking lot, drive, and front aisle areas shall be controlled such that exterior luminaires shall not operate during hours of daylight. Controls may include a combination photocell plus time switch or an energy management system. Controls shall allow automatic on and off settings based on daylighting, plus timed off settings after expected activity ends. Energy management system shall have pre-determined control strategies to include automatic dimming for adaptive standards. Dimming controls shall work with a 0-10V dimmable driver.

2.3.7 LED Luminaire Photocell Switch

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell, rated [_____] volts ac, 60 Hz, with[single-throw contacts][single pole double-throw (spdt) contacts for mechanically held contactors rated [1000][1800] watts] designed to fail to the ON position. Switch shall turn on at or below 32 lux (3 footcandles) and off at 43 to 107 lux (4 to 10 footcandles). A time delay shall prevent accidental switching from transient light sources. [Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.] Provide switch:

a. Compliant with Reduction of Hazardous Substances (RoHS).

b. Utilizing an ambient light sensing technology which inherently minimizes the contribution of typical high power LED light sources to the sensed light level.

c. With a rated life expectancy of 90,000 hours continuous operation.

d. [In a high-impact-resistant, noncorroding and nonconductive molded plastic housing with a [fixture mounted] locking-type receptacle conforming to ANSI C136.10 and rated 1800 VA, minimum.]

e. [In a cast weatherproof aluminum housing with adjustable window slide,

rated 1800 VA, minimum.]

f. [In a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.]

g. [Integral to the luminaire, rated 1000 VA, minimum.]

2.3.8 LED Luminaire Time Switch

Astronomic dial type or electronic type, arranged to turn "ON" at sunset, and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide switch rated [_____] volts, having automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of 7 hours following power failure. Provide time switch with a manual on-off bypass switch. Housing for the time switch shall be surface mounted, NEMA [3R][_____] enclosure conforming to NEMA ICS 6.

[2.3.9 LED Luminaire Curfew Control

Provide curfew control. Curfew Control shall include after hours dimming control to reduce light levels to approximately [50%] [___] of full lumen output at a predetermined time. This time setting will normally be after expected activity ends. Design controls to fail to the ON full output position.

[2.3.10 LED Luminaire Occupancy Sensor Controls

NEMA WD 7, UL 773A. Provide passive infrared or microwave sensor with 360° coverage, time delay that can be adjusted from 30 seconds to 30 minutes, and designed to fail to the ON position. Sensors shall be located to achieve coverage of areas indicated. Coverage patterns shall be derated as recommended by manufacturer based on mounting height of sensor and any obstructions such as trees. Do not use gross rated coverage in manufacturer's product literature. Sensors integral to the luminaire must be provided by luminaire manufacturer.

a. Infrared: Integral to the luminaire. Shall detect occupancy by changes in infrared energy within a coverage area and shall be capable of operating between -40°C and +50°C.

b. Microwave: Integral to luminaire. Shall detect occupancy by transmitting electromagnetic energy into a coverage area, receiving direct and reflected energy, and monitoring frequency shift between transmitted and received signals. When more than one device is used in an area, devices shall operate on different frequencies. Provide for selective filtering by the sensor to minimize nuisance tripping due to interference from radar, or other sources of electronic interference.

2.4 LIGHTING CONTACTOR

NEMA ICS 2,[electrically][mechanically] held contactor.[Contacts shall be rated [_____] volts, [_____] amperes, and [_____] poles. Coils shall be rated [_____] volts.][Rate contactor as indicated.] Provide in NEMA[4][_____] enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts [and coil clearing contacts for mechanically

held contactor] and shall require no arcing contacts.[Provide contactor with[hand-off-automatic][on-off] selector switch.][Contactor shall be hermetically sealed.]

2.5 TIME SWITCH

Astronomic dial type or electronic type, arranged to turn "ON" at sunset, and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide switch rated [_____] volts, having automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of 7 hours following power failure. Provide time switch with a manual on-off bypass switch. Housing for the time switch shall be surface mounted, NEMA [3R][_____] enclosure conforming to NEMA ICS 6.

2.6 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated [_____] volts ac, 60 Hz with[single-throw contacts][single pole double-throw (spdt) contacts for mechanically held contactors rated 1000 watts] designed to fail to the ON position. Switch shall turn on at or below 32 lux 3 footcandles and off at 43 to 107 lux 4 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources.[Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.] Provide switch:

[a. In a high-impact-resistant, noncorroding and nonconductive molded plastic housing with a[fixture mounted,] locking-type receptacle conforming to ANSI C136.10 and rated 1800 VA, minimum.]

[b. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.]

[c. In a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.]

[d. Integral to the luminaire, rated 1000 VA, minimum.]

2.7 POLES

Provide poles designed for wind loading of [161][_____] km/hr [100][_____] miles per hour determined in accordance with AASHTO LTS-5 while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be[embedded][anchor]-base type designed for use with[underground][overhead] supply conductors.[Poles[, other than wood poles,] shall have oval-shaped handhole having a minimum clear opening of 65 by 130 mm 2.5 by 5 inches. Handhole cover shall be secured by stainless steel captive screws.][Metal poles shall have an internal grounding connection accessible from the handhole near the bottom of each pole.] Scratched, stained, chipped, or dented poles shall not be installed.

2.7.1 Concrete Poles

Provide concrete poles conforming to ASTM C 1089. Cross-sectional shape shall be[round][or][multi-sided].

2.7.1.1 Steel Reinforcing

Prestressed concrete pole shafts shall be reinforced with steel prestressing members. Design shall provide internal longitudinal loading by either pretensioning or post tensioning of longitudinal reinforcing members.

2.7.1.2 Tensioned Reinforcing

Primary reinforcement steel used for a prestressed concrete pole shaft shall be tensioned between 60 to 70 percent of its ultimate strength. The amount of reinforcement shall be such that when reinforcement is tensioned to 70 percent of its ultimate strength, the total resultant tensile force does not exceed the minimum section compressive strength of the concrete.

2.7.1.3 Coating and Sleeves for Reinforcing Members

Where minimum internal coverage cannot be maintained next to required core openings, such as handhole and wiring inlet, reinforcing shall be protected with a vaporproof noncorrosive sleeve over the length without the 13 mm 1/2 inch concrete coverage. Each steel reinforcing member which is to be post-tensioned shall have a nonmigrating slipper coating applied prior to the addition of concrete to ensure uniformity of stress throughout the length of such member.

2.7.1.4 Strength Requirement

As an exception to the requirements of ASTM C 1089, poles shall be naturally cured to achieve a 28-day compressive strength of 48.23 MPa 7000 psi. Poles shall not be subjected to severe temperature changes during the curing period.

2.7.1.5 Shaft Preparation

Completed prestressed concrete pole shaft shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost, and shall be clean, smooth, and free of surface voids and internal honeycombing. Poles shall not be installed for at least 15 days after manufacture.

2.7.2 Aluminum Poles

Provide aluminum poles manufactured of corrosion resistant aluminum alloys conforming to AASHTO LTS-5 for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys. Poles shall be seamless extruded or spun seamless type with minimum 4.8 mm 0.188 inch wall thickness. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Tops of shafts shall be fitted with a round or tapered cover. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded. Base cover shall be cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel.[Aluminum

poles and brackets for [walkway][_____] lighting shall have a[uniform satin][dark anodic bronze][_____] finish to match fixtures and shall not be painted.] Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

2.7.3 Steel Poles

AASHTO LTS-5. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 331 MPa 48,000 psi and[hot-dipped galvanized in accordance with ASTM A123/A123M][iron-oxide primed] factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Pole shall be[direct set][anchor bolt mounted] type. Poles shall have tapered tubular members, either round in cross section or polygonal.[Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved.] Pole markings shall be approximately 900 to 1270 mm 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, and length.[Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 248 MPa 36,000 psi.]

2.7.4 Wood Poles

ATIS ANSI O5.1 and RUS Bull 1728F-700 of[Southern Yellow Pine][Douglas Fir][_____]. Poles shall be gained, bored, and roofed before treatment. Poles shall be treated full length with chromated copper arsenate (CCA) or ammoniacal copper arsenate (ACA) according to AWPA C1 and AWPA C4 as referenced in RUS Bull 1728F-700. Poles shall be branded by manufacturer with manufacturer's mark and date of treatment, height and class of pole, wood species, preservation code, and retention. Place the brand so that the bottom of the brand or disc is 3050 mm 10 feet from the pole butt for poles up to 15250 mm 50 feet long[and 4270 mm 14 feet from the butt for poles over 15250 mm 50 feet long].

2.7.5 Fiberglass Poles

ANSI C136.20. Designed specifically for supporting luminaires and having factory-formed cable entrance and handhole. Resin color shall be[dark bronze][as indicated][_____], and pigment shall provide uniform coloration throughout entire wall thickness. Finish surface shall be pigmented polyurethane having a minimum dry film thickness of 0.038 mm 1.5 mils. Polyurethane may be omitted if the surface layer of the pole is inherently ultraviolet inhibited. Minimum fiberglass content shall be 65 percent with resin and pigment comprising the other 35 percent material content.

2.8 BRACKETS AND SUPPORTS

ANSI C136.3, ANSI C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 31.75 mm 1 1/4 inch[galvanized steel pipe][aluminum] secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 7320 mm 24 feet above street. Special mountings or brackets shall be as indicated and

shall be of metal which will not promote galvanic reaction with luminaire head.

2.9 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 344.5 MPa 50,000 psi; the top 305 mm 12 inches of the rod shall be galvanized in accordance with ASTM A153/A153M. Concrete shall be as specified in[Section 03 30 00 CAST-IN-PLACE CONCRETE][Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE].

[2.10 AUXILIARY INSTANT-ON QUARTZ SYSTEM

UL listed, automatically switched instant-on[150][250]-watt[quartz][_____] lamp. Quartz lamp shall come on when the luminaire is initially energized and immediately after a momentary power outage, and remain on until HID lamp reaches approximately 60 percent light output. Wiring for quartz lamp shall be internal to ballast and independent of incoming line voltage to the ballast.[Provide instant-on quartz system for each HID fixture.][Provide instant-on quartz system as indicated.]

2.11 EQUIPMENT IDENTIFICATION

2.11.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.11.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific lamps and ballasts according to proper lamp type. The following lamp characteristics shall be noted in the format "Use Only _____":

a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

c. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.

d. ANSI ballast type (M98, M57, etc.) for HID luminaires.

e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.12 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

[3.1.1 Wood Poles

Pole holes shall be at least as large at the top as at the bottom and shall be large enough to provide 100 mm 4 inches of clearance between the pole and the side of the hole.

a. Setting depth: Pole setting depths shall be as follows:

Length of Pole	Setting in Soil
6100 mm (20 feet)	1575 mm
7625 mm (25 feet)	1575 mm
9150 mm (30 feet)	1575 mm
10675 mm (35 feet)	1830 mm
12200 mm (40 feet)	1830 mm
13725 mm (45 feet)	1985 mm
12250 mm (50 feet)	2135 mm
16775 mm (55 feet)	2285 mm
18300 mm (60 feet)	2440 mm

Length of Pole (feet)	Setting in Soil (feet)
20	5.0
25	5.5
30	5.5
35	6.0
40	6.0
45	6.5
50	7.0
55	7.5
60	8.0

b. Soil setting: "Setting in Soil" depths shall apply where pole holes are in soil, sand, or gravel or any combination of these.[At corners, dead ends and other points of extra strain, poles 12,200 mm 40 feet long or more shall be set 150 mm 6 inches deeper.]

c. Setting on sloping ground: On sloping ground, measure the depth of the hole from the low side of the hole.

d. Backfill: Tamp pole backfill for the full depth of the hole and mound the excess fill around the pole.

[3.1.2 Concrete Poles

Install according to pole manufacturer's instructions.

[3.1.3 Fiberglass Poles

Install according to pole manufacturer's instructions.

[3.1.4 [Aluminum][Steel] Poles

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section[33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION][33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND]. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.[After installation, paint exposed surfaces of steel poles with two finish coats of[exterior oil paint of a color as indicated][aluminum paint].]

3.1.5 Pole Setting

[Depth shall be as indicated.][Poles in straight runs shall be in a straight line. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 150 mm 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.]

3.1.6 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.[Mount switch on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm.][Set adjustable window slide for [_____] lux [_____] footcandles photocell turn-on.]

3.1.7 GROUNDING

Ground noncurrent-carrying parts of equipment including[metal poles,] luminaires, mounting arms, brackets, and metallic enclosures as specified in Section[33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION][33 70 02.00 10 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND]. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.1.8 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --

fats
VIRTUAL
TRAINING
SOLUTIONS
COMPANY

RECOMMENDED TRAINING FACILITY DESIGN DOCUMENT

For the
FATS Virtual Trainer

Version 1.2
11 August, 2011

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Training Facility Design Document

1 INTRODUCTION.

This Recommended Training Facility Design Document contains information to be used in the planning stages for construction of a training facility for housing the FATS Virtual Trainer.

2 PREPARING THE TRAINING FACILITY.

This section provides information that is required for preparing the site for installation and operation of the FATS Virtual Trainer in the single and multiple screen configurations.

2.1 GENERAL FACILITY LAYOUT.

FATS recommends a facility layout that includes a Training Room(s), Weapon Storage Room, Compressor Room, and Office.

- **Training Room -** All training will be conducted in the Training Room, which houses all simulation equipment.
- **Weapon Storage Room -** The Storage Room provides for simulated weapon storage.
- **Compressor Room –** The compressor room houses the air compressor, and/or the carbon dioxide (CO_2) bottles providing compressed air or CO_2 for weapon recoil of non-Bluefire weapons.
- **Office -** The office provides a work base for the Training Facility manager.

2.2 TRAINING ROOM.

2.2.1 Overview – Training Room.

The Training Room(s) will house the Virtual Trainer, a system operator, 1-3 instructors, and observers. A diagrammatic layout is in Attachment A.

2.2.2 Size Requirements – Training Room.

Training Rooms should measure 45’ x 25’ (13.716m X 7.62m) for a single screen system. (Minimum requirements for a single screen system are 15’ x 30’ / 4.572m x 9.144m) If multiple systems are being utilized, the room dimension will increase. Refer to Attachment A. The physical dimensions of the Training Room should be sufficient to accommodate a 5/10/15-lane Virtual Trainer with an Instructor Station, firing line for trainees, projector, screen, speakers, and training furniture. Training room dimensions must take into account the critical placement of FATS system components relative to each other as identified in the facility diagrams in Attachment A. For example, the projector must be placed a distance of 230” (5.842m) from the screen, while the firing line must be located 20’ (6.069m) from the screen. Placement of other system components can be customer defined, as long as maximum cable lengths are not exceeded and proper line of sight is maintained from the instructor to student and projection screen. FATS suggest an optimal placement for the Instructor’s Station and the associated hardware and controls as indicated in the facility diagrams in Attachment A. That location will allow the instructor to have an unobstructed view of the screen and the firing line, and at the same time have access to the rooms electrical controls such as thermostat, fluorescent and dimmable lights. If the customer desires a different location, please discuss the desired new location with FATS to avoid potential problems.

Please Note: If Mortars or a Mk-19 are being used on the system, please allow approximately 4’ x 4’ (1.2192m X 1.2192m) for the Mortar/MK-19 platforms.
The projector distance may vary depending on the model purchased. Please check with FATS, Inc. for specific distances for your projector.

=

2.2.3 Flooring Requirements – Training Room.

It is recommended that a 2' (0.6096m) raised firing platform be constructed for the trainees. It should be made out of solid wood or another material that minimizes vibrations due to people walking and moving about on the floor since vibration can adversely affect the shooters performance. The firing platform should have a crawl space underneath it to allow for running system cables and hoses to reduce clutter. It should also have openings at the indicated locations for the projector and for access to the crawl space. In this configuration, all weapon umbilicals run to the front of the firing line, eliminating floor clutter. Speaker and intercom cables can also be routed to positions in front of the firing line where they do not interfere with the trainee's view of the screen. The Training Room floor should be smooth and level to within 1" (.0254m) between any two points. The Training Room floor, including the firing platform, should be covered with short, closed pile, anti-static, textured dark gray or black commercial carpet. Carpet controls dust and feels more like the ground when firing from a prone position. It is especially important to have the floor carpeted or covered with rubber mats when using Bluefire weapons where the magazines or weapon itself, such as the OC spray, are allowed to fall on the floor to simulate reloading or out of chemical drills.

Please Note: In the floor mount configuration, the bottom of the screen and the projector should be at the same level. In the ceiling mount configuration, the top of the screen and the projector (inverted) should also be at the same level.

2.2.4 Ceiling Requirements – Training Room.

The minimum height of the ceiling in the training room should provide sufficient room to raise the screen. Add an additional 2' (0.6096m) for the raised platform making the top of the screen 10'-12' (3.048m – 3.657m) off the floor. The ceiling should be painted flat black to match the walls and eliminate light reflection.

Please Note: The Ceiling will need to be higher if ceiling mounts are used and may add another foot to the overall ceiling height. If a ceiling mount for the projector is being used, please ensure the mount hangs at the same level as the TOP of the screen and centered left to right.

2.2.5 Door Requirements – Training Room.

One rear entry door should be provided to provide for personnel access to the Training Room. This door should be electric/key unlock (normally locked), solid, sound attenuating. Door will lock only from outside. This personnel access door should be an interior door to minimize potential exterior noise, environmental conditions, and debris. All FATS equipment is designed to fit through standard door openings. There should be no light passing through the door when closed (i.e., no light transmission detected in darkened Training Room when viewing door using standard night vision device). Ideally, no light should reflect on the screen when any outside doors are opened. Please check with local fire/evacuation regulations.

2.2.6 Wall Finish Requirements – Training Room.

All walls in the Training Room should be painted with "flat" black paint to minimize light reflections that could interfere with the Virtual Trainer hit detect system.

Please Note: Instead of using the supplied screen, you can paint the wall (the one behind the screen) flat white and use it in place of the screen for system-controlled weapons only. When using laser inserts it is recommended you use the provided screen.

2.2.7 Window Restrictions – Training Room.

For new facilities, no windows should be included in the Training Room. If there are windows present, make sure they are completely sealed so “NO” ambient/natural light can pass through.

2.2.8 Environmental Requirements – Training Room.

The FATS Virtual Trainer is designed for indoor use, and is typically operated in room temperatures that are adjusted to personnel specifications. Air conditioning is recommended for temperature and humidity control (controllable via dedicated thermostat). The heat load from the two-system Virtual Trainer is equivalent to that of 3 office PCs, a monitor, 2 projectors, sound amplifier and a printer, and the total power would not exceed 1400w. The training room environment should maintain temperatures and climate that is within the operating range of the training system. The safe operating temperature limits for the Virtual Trainer system are between +5 and +35 degrees Centigrade (or +41 to +95 degrees Fahrenheit). The relative non-condensing humidity limits are 20 to 85 percent. The Virtual Trainer is designed to operate successfully in a wide variety of climates and conditions. Still, avoid dust-producing items (leaking sandbags, dirt floors, deteriorating camouflage materials, etc) especially around the desks, projectors, and weapons. Excess dust can be damaging to Virtual Trainer components. Access to the Training Room should prevent wind-blown dust or precipitation from entering the room via poorly sealed doors or windows. For existing facilities, moisture producing items such as leaking or sweating pipes and damaged roofs must be repaired. Please note that air conditioning vents should not be placed near Virtual Trainer projection screens, since slight movements or ripples in the screen surface can reduce overall system accuracy. Any source of IR light such as Exit signs or heaters should not be place near the screen where it is in the field of view of the hit cameras.

PLEASE NOTE: BLUEFIRE WEAPON INFO

If Bluefire weapons are to be used, then excessive RF (radio frequency) from devices not FCC approved should be avoided. Bluefire operates using Bluetooth technology in the 2.4 GHz frequency range. The training room should be in a location where wireless devices can be used. If there are known RF interferences that prevent other devices in the 2.4 GHz spectrums such as cordless phones, wireless computer networks or other Bluetooth devices from operating properly, then the room must be RF shielded. Please contact FATS, Inc for more details. So far in the many installations, trade shows and demonstration locations that have FATS’ Bluefire weapons, there has not been any instances where there is enough RF interference to affect the performance of the Bluefire weapons.

2.2.9 Sound Insulation Requirements – Training Room.

The simulated firing audio system is fitted with a volume control to adjust the audio volume level for weapon shot sounds, battlefield sounds, and normal scenario feedback. When training is being conducted, the sound of the simulated weapons and scenario sounds should be loud enough for realism. However for safety purposes, the audio volume of the Virtual Trainer is designed not to exceed a peak exposure (generally shot sounds) of 110 dBA to prevent damage to the operator and/or trainee’s hearing.

The level of noise that escapes from the Training Room during operation depends on the amount of sound insulation materials used in construction of the facility (dry wall, sound lagging, insulation materials, thickness of walls and bulkheads, etc.). An air conditioned facility and use of normal building materials typically are adequate to reduce noise (shot sounds, etc) from the trainer to building exterior.

2.2.10 Power Requirements – Training Room.

The FATS Virtual Trainer operates using 100-240 VAC, 50-60 Hz power. The Virtual Trainer will auto switch, but there are some components that may need to be changed by a FATS Technician prior to installation. A 100–240 VAC Transformer may also be supplied with the system.

1) **Instructor Station Power** - dedicated filtered circuit (i.e., Virtual Trainer power should be isolated from power circuits supplying other equipment within the facility) 100-240 VAC, 50-60 Hz, 15A single phase - outlet mounted on the wall within six feet of the Instructor Station (preferably at the location indicated on the facility layout drawings in Attachment A), at 3' off the room floor (1' above the firing platform).
2) **Other Power** – 100-240 VAC, 50-60 Hz, 15A single phase outlets on separate circuits evenly spaced around the room for use with maintenance and miscellaneous equipment (circuits isolated from system circuits).

A single point of ground (earth) shall be provided for the entire AC system. Ground impedance shall be less than one ohm measured at any outlet or connecting device.

2.2.11 Telephone Line Requirements – Training Room.

Two analog telephone lines are recommended for use in system upgrades and remote diagnostics by FATS, Inc. Provision of telephone lines is desirable to support file and scenario transfer rates used in HLA.

2.2.12 Lighting Requirements – Training Room.

A common problem with many customer simulator-training rooms is that they are either too dark or too bright. This comes from having little or no control over ambient (room) lighting, or from having lights in the wrong locations. To maximize projected image clarity and saturation and eliminate interference with laser hit detect sensor, Training Room lights in the area of the projector and screen must be turned OFF to keep this area in deep shadow. While this reduced light level aids the Virtual Trainer projection system, it potentially limits both the trainee on the firing line and operator at the instructor station. For example, low light levels at the firing line makes it difficult for trainees to fill out score notebooks or easily see weapon sights. In addition, the Virtual Trainer operator is forced to work in darkness, making it difficult to impossible to effectively review training aids. Therefore, dedicated recessed (focused) dimmable lighting is important for lighting the firing line and the Instructor Station position. It is best for all room lighting to be adjustable by the operator from the Instructor Station location. Proper use of operator-controlled lighting enables use of different light levels within the Training Room, allowing screen images to remain sharp and clear while enabling the trainees and operator to see what they are doing. During simulator operation, recessed dimmable fluorescent, compact fluorescent or low IR lights are recommended for use over the firing line and instructor station. Any other kinds of light such as halogen and incandescent lights generate significant amounts of IR light that can potentially interfere with the system's hit detection. For general room lighting when the simulator is not in use, standard florescent lights are acceptable. It is preferable if the fluorescent lights are separated in front of the firing platform and are on a separate bank from the ones over the firing platform.

2.2.13 Furniture Requirements – Training Room.

Training room size should be sufficient to support use of additional training furniture such as simulated sandbags, camouflage netting, trenches, etc. These items are not part of the contract, and would be constructed and installed by the customer. If desired, FATS can discuss things accomplished by other customers in this area.

Note: Simulated Sandbags – An actual sand bag filled with foam peanuts or another similar product. This prevents the possibility of sand getting into the weapons and/or electrical components. It is recommended that you use wet sawdust sealed in a plastic bag, then placed inside a sandbag.

2.2.14 Air Flow Specifications – Training Room.

The FATS system can use Compressed Air, CO_2 or Nitrogen (N_2) for simulated weapon recoil, therefore no smoke or poisonous gases will be discharged from the simulated weapons. FATS simulated weapons can operate using CO_2 canisters. Compressed air can also be used as a costed option. If compressed air

is used, it must be dry and filtered to prevent contamination. Another issue with compressed air or nitrogen is that they will not last as long as the CO_2 because they are stored as a gas where the CO_2 is stored as a liquid and turns into a gas replenishing the gas supply. Facility airflow should be designed to support training room occupancy for up to 12 trainees, 1-3 instructors, and observers simultaneously.

Note: *If Compressed air or Nitrogen is used, special regulators that can support a higher PSI need to be used and will be an additional cost. A list of all weapon types and associated PSI levels can be provided upon request.*

2.2.15 Cable Routing Requirements – Training Room.

The cables from the equipment rack to the projector and hit camera, as well as the trunk lines for the weapons will run underneath the firing platform. It is required that a 6" (0.1524m) diameter hole is cut out in the firing platform behind the equipment rack. If a raised platform cannot be used, it is recommended that floor tunnels be used to hide cables. If a good tunnel structure exists, there should not be a need for a raised platform.

2.3 WEAPONS STORAGE ROOM.

2.3.1 Size Requirements - Storage Room.

The size of the Storage Room should be sufficient to store training furniture and simulated weapons (unless stored in another secured lockup area) when not in use. Actual size of this room is left to the discretion of the customer – no formal requirement exists relative to the operation of the Virtual Trainer.

2.3.2 Power Requirements - Storage Room.

There are no special power requirements for the Storage Room. However, it is recommended to add a couple of power outlets to this room for future use (easier and cheaper to add now than later). If **Bluefire** weapons are to be used, power outlets are required for the battery chargers to charge up the batteries inside the weapon simulator overnight. It is important to keep the Bluefire weapons, like with any battery-powered device, charging when not in use to ensure the weapons are operational at a moment's notice.

2.3.3 Environmental Requirements - Storage Room.

Since system equipment will be stored in the Storage Room, this room should be heated and cooled in a similar manner as the rest of the facility.

2.3.4 Lighting Requirements - Storage Room.

General-purpose lighting should be provided for the storage room.

2.3.5 Access – Storage Room.

The Storage Room should easily accessible from the Training Room. Double doors identical to the ones used for the training room are recommended to facilitate easy movement of equipment in and out of the Weapon Storage Room. The room's doors and windows (if present) should be compliant with customer's standards for storage of simulated weapons.

2.4 COMPRESSOR ROOM (FOR TETHERED WEAPONS).

2.4.1 Size Requirements – Compressor Room.

The size of the Compressor Room should be sufficient to house the compressor skid-mounted assembly if purchased by the customer.

2.4.2 Power Requirements - Compressor Room.

There are no special power requirements for the Compressor Room. However, it is recommended to add a couple of power outlets to this room for future use (easier and cheaper to add now than later). If the customer purchases a separate air compressor, the proper power requirements will need to be adhered to in accordance with the manufacturer of the air compressor.

2.4.3 Environmental Requirements - Storage Room.

It is recommended that this room should be heated and cooled in a similar manner as the rest of the facility especially since it will house the Co2 canisters.

2.4.4 Lighting Requirements - Storage Room.

General-purpose lighting should be provided for the storage room.

2.4.5 Access – Compressor Room

The Storage Room should easily accessible from the Training Room. If the customer purchases a compressor, the access to the room should be through double-doors with a minimum width of at least 6' to allow for the compressor skid to be moved in the room. In the interest of safety, only authorized personnel should have access to this room.

2.5 OFFICE.

An office is recommended for the Training Room manager. This office will be used for Training Room scheduling and general management activities. Size, access, furnishing, and environmental control of this office are left to customer discretion.

2.6

Safety Concerns: All safety issues need to be addressed locally by the customer. Some of the safety concerns are:

- Steps in the training area should be lighted to prevent students from tripping.
- Exposed Cables/hoses could be a possible trip hazard.
- CO_2/Nitrogen canisters need to be secured so they don't fall or get knocked over.
- Fire extinguisher should be available.
- Exit lighting
- Emergency shutoff
- Every weapon needs to be treated as a live weapon.

Note: More safety concerns are also covered in the System O&M Manual.

2.7 BLUEFIRE WEAPONS

Bluefire weapons with recoil require the use of a magazine refill station. This station occupies about 1 cubic feet of space and should be set on a sturdy table and nearby the firing line in order for students to easily refill their magazines to minimize down time. This station requires a Nitrogen canister that needs to be provided by the customer. FATS recommends our customers rent this canister and have a service that fills the canister on a regular basis depending on usage. The canister is the tall kind (that weighs over 200 lbs) and requires it to be strapped down or in a rolling rack to prevent it from falling over and causing a potential hazard. The specifications of the canister should be as follows.

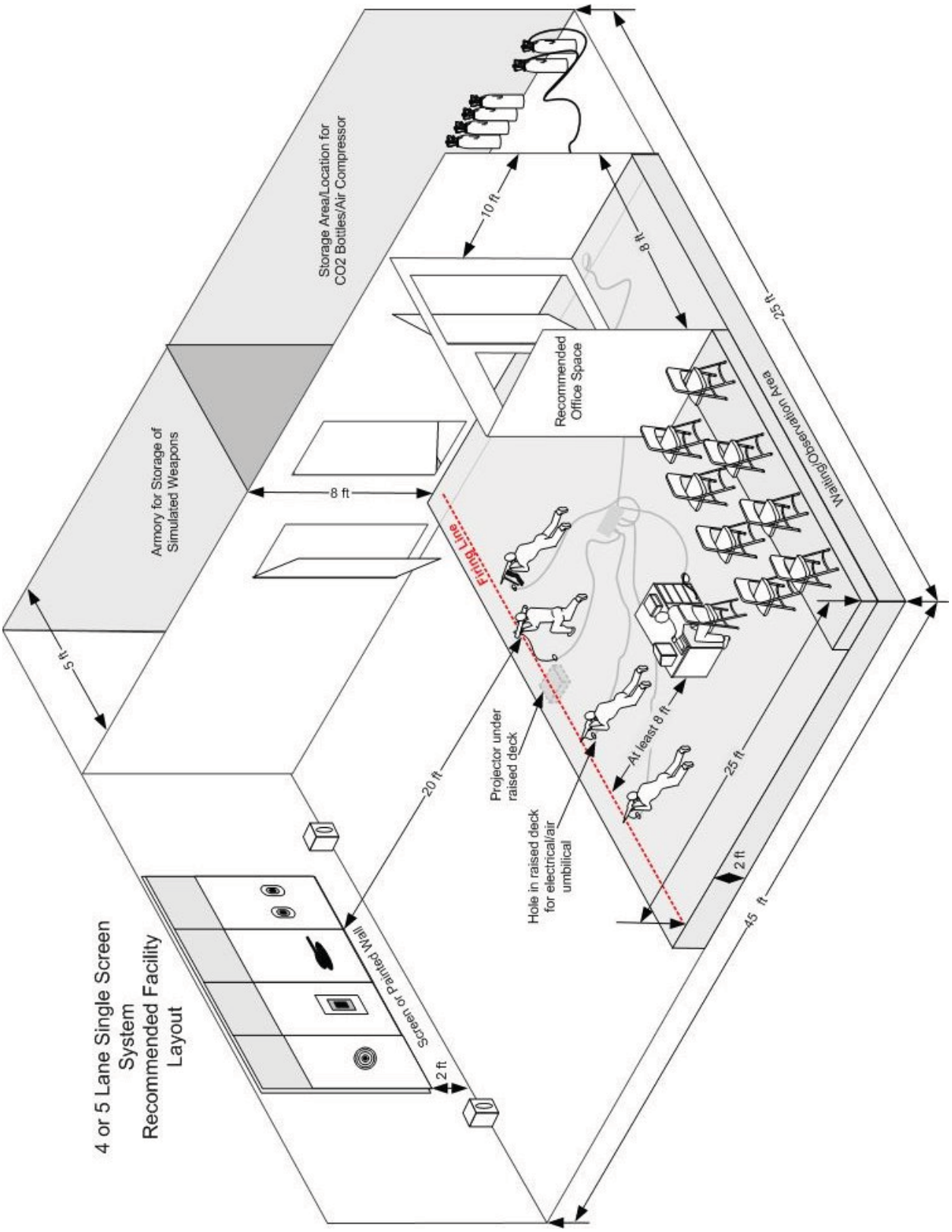
Canister/tank pressure: 5000-6000 PSI
Fitting: CGA-677
Gas: High Pressure Nitrogen

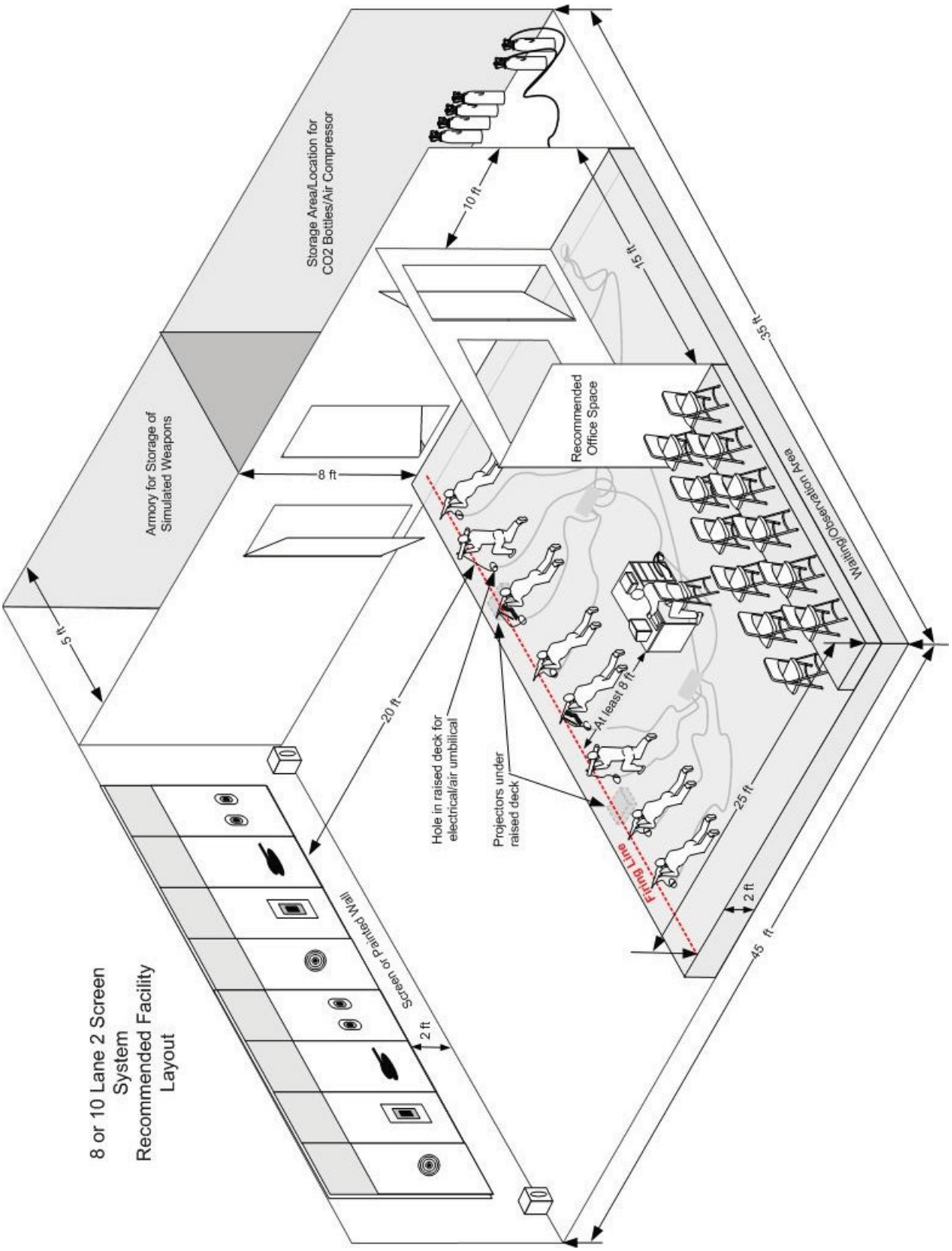
Bluefire weapons have a range of about 33 feet from the weapon's dongle (transceiver unit that allows the wireless communication between the weapon and the system), which plugs into the FATS simulation computer. The dongle currently has a cable length of about 25 feet with a connector that plugs into the weapon port of the FATS computer. For optimal performance, it is recommended that each dongle be placed in the center of the projected area in front of the firing line closer to the screen than the firing line. If there is going to be a lot of anticipated movements where the students can potentially trip over the cables, then the dongle can be mounted in the ceiling or be used with a weapon trunkline so that the cable run along side the sides of the room and out of the way of the students.

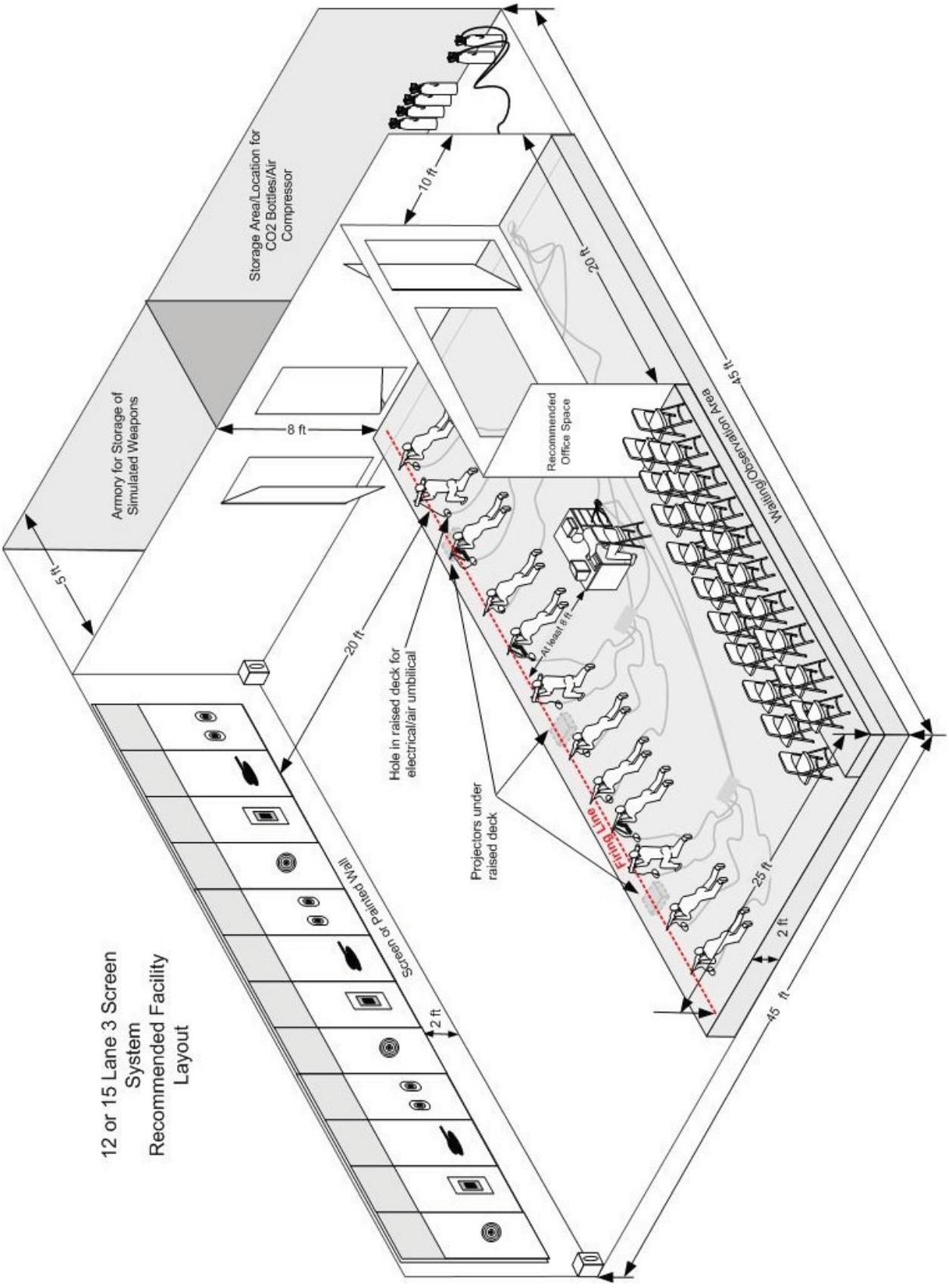
Since Bluefire weapons look very similar to its live weapon counterpart, it is imperative that there is some kind of policy or procedure in place to prevent live weapons from entering into the FATS training room and Bluefire weapons from leaving the training room. This may include a lockable cabinet for students to check in their live weapons before going into the FATS Training room.

If there are to be any props for students to practice cover drills with, it is recommended to avoid all metal props or dividers because metal has a tendency to limit the range of any wireless link by shielding the RF signals. This can cause problems in the operation of the weapon and system.

ATTACHMENT A: Training Room Layout Drawings


4 or 5 Lane Single Screen System Recommended Facility Layout
Screen or Painted Wall
2 ft
20 ft
Armory for Storage of Simulated Weapons
5 ft
8 ft
Storage Area/Location for CO2 Bottles/Air Compressor
10 ft
Recommended Office Space
8 ft
25 ft
Waiting/Observation Area
Firing Line
At least 8 ft
Projector under raised deck
Hole in raised deck for electrical/air umbilical
25 ft
2 ft
45 ft


8 or 10 Lane 2 Screen System Recommended Facility Layout
Storage Area/Location for CO2 Bottles/Air Compressor
Armory for Storage of Simulated Weapons
10 ft
15 ft
55 ft
8 ft
5 ft
Recommended Office Space
Waiting/Observation Area
20 ft
Hole in raised deck for electrical/air umbilical
Projectors under raised deck
At least 8 ft
Firing Line
25 ft
2 ft
45 ft
Screen or Painted Wall
2 ft


12 or 15 Lane 3 Screen System Recommended Facility Layout
Armory for Storage of Simulated Weapons
Storage Area/Location for CO2 Bottles/Air Compressor
10 ft
20 ft
45 ft
8 ft
5 ft
Recommended Office Space
Waiting/Observation Area
At least 6 ft
20 ft
Hole in raised deck for electrical/air umbilical
Projectors under raised deck
Firing Line
25 ft
2 ft
45 ft
Screen or Painted Wall
2 ft